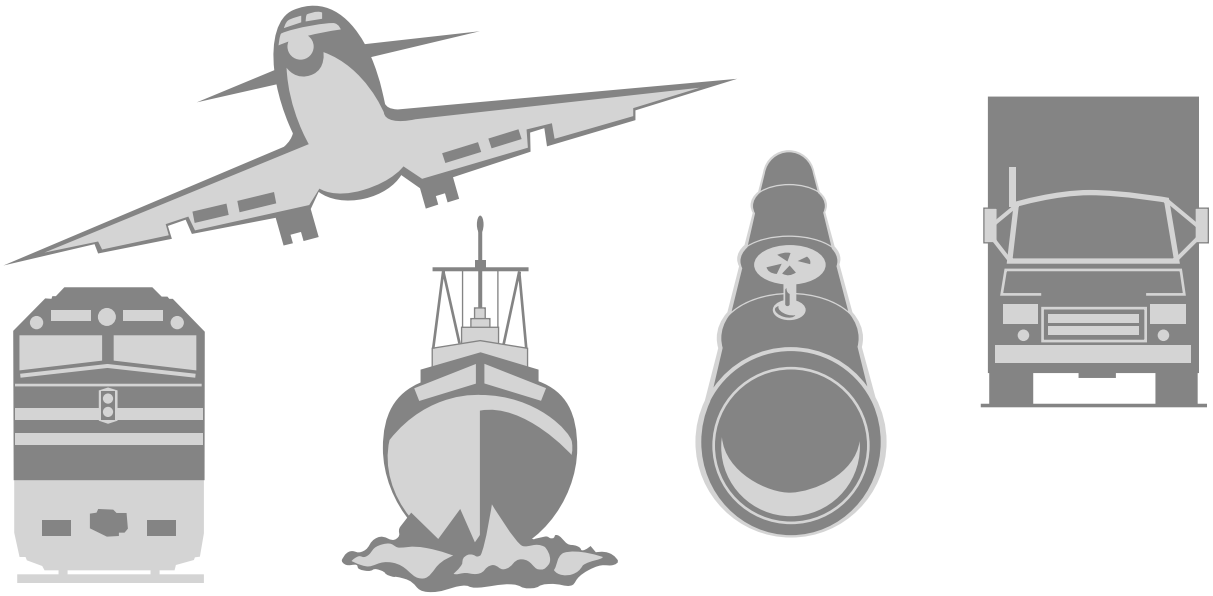
PB2002-916601
NTSB/REC-02/01

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY RECOMMENDATIONS

ADOPTED JANUARY 2002



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 4, 2002

In reply refer to: A-01-83 through -87

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Recent In-Flight Fires

Delta Air Lines Flight 2030

On September 17, 1999, about 2230 eastern daylight time, a McDonnell Douglas MD-88, N947DL, operated by Delta Air Lines as flight 2030, experienced an in-flight fire and made an emergency landing at the Cincinnati and Northern Kentucky International Airport in Covington, Kentucky.[1] After landing, an emergency evacuation was performed. The airplane sustained minor damage, and none of the 2 flight crewmembers, 3 flight attendants, 3 off-duty flight attendants, or 113 passengers were injured.

Shortly after takeoff, several flight attendants detected a sulphurous or "lit match" smell and reported it to the flight crew. Following the captain's instructions, flight attendants checked the lavatories, but were unable to locate the cause of the smell. Two off-duty flight attendants retrieved Halon fire extinguishers when flight attendants noticed smoke in the forward section of the coach cabin.[2] Flight attendants reseated a passenger in row 11 to another row when he stated that his feet were hot. This individual's carry-on bag, which had been on the floor beside him, next to the right sidewall and above the floor vent, was scorched. Flight attendants also reported seeing an orange or red, flickering glow beneath the vent at that location.

[1] The description for this accident, NYC99IA231, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[2] In comparison, on March 17, 1991, a Delta Air Lines L-1011 experienced a fire below the aft cabin floor that produced visible flames in the cabin. According to an August 14, 1991, Safety Board letter, "a flight attendant promptly discharged a Halon fire extinguisher into an opening in the base of the sidewall from which the flames appeared to originate. The fire was extinguished and a precautionary landing was made at Goose Bay."

Flight attendant No. 1 went to the cockpit to inform the flight crew of these observations and asked the captain whether to spray Halon into the vent where she had seen the glow. The captain instructed her not to use the Halon extinguisher, indicating he was concerned about spraying Halon in the cabin. Meanwhile, another flight attendant had already discharged a Halon fire extinguisher into the vent and observed that the glow was no longer visible. Thereafter, the smoke began to dissipate and did not return, indicating that the fire had been extinguished by the Halon. When flight attendant No. 1 returned from the flight deck, she became alarmed that a Halon fire extinguisher had been discharged because the captain had instructed her not to do so.

During its investigation of this incident, Safety Board staff discovered that the source of the smoke in the cabin was a smoldering insulation blanket in the cargo compartment adjacent to a static port heater. Electrical arcing from the heater ignited the blanket, and the smoldering became a self-sustaining fire that grew in size.[3]

AirTran Flight 913

On August 8, 2000, about 1544 eastern daylight time, a McDonnell Douglas DC-9-32, N838AT, operated by AirTran Airways (AirTran) as flight 913, experienced an in-flight fire and made an emergency landing at the Greensboro Piedmont-Triad International Airport in Greensboro, North Carolina.[4] An emergency evacuation was performed. The airplane was substantially damaged from the effects of fire, heat, and smoke. Of the 57 passengers and 5 crewmembers on board, 3 crewmembers and 2 passengers received minor injuries from smoke inhalation, and 8 other passengers received minor injuries during the evacuation.

Shortly after takeoff, flight attendants No. 1 and No. 2, who were seated on the forward jumpseat, both smelled smoke. Flight attendant No. 1 went to the cockpit, where she saw smoke "everywhere" and noticed that the crew had donned their oxygen masks. The captain told her that they were returning to Greensboro. She closed the cockpit door and returned to the cabin. She and flight attendant No. 2 reseated themselves in empty seats in business class because of the rapidly accumulating smoke in the galley area around their jumpseats.

Flight attendant No. 1 reported that the smoke became so dense she could no longer see the forward galley. However, neither flight attendant made any effort to locate the source of the smoke or to use any of the firefighting equipment available to them. Flight attendant No. 1 saw a large amount of electrical "arcing and sparking" and heard "popping noises" at the front of the cabin. She told investigators that she "debated whether to use the Halon" fire extinguisher but was unsure where to aim it. She decided not to use the Halon fire extinguisher because she "did not see a fire to fight." As discussed later in this letter, AirTran's flight attendant training program does not include any drill involving hidden fires but does include a drill that uses a

[3] As a result of this incident, on February 6, 2001, the Safety Board issued to the FAA three recommendations (A-01-003, A-01-004, and A-01-005) regarding the inspection and design of static port heaters and the possible replacement of existing insulation blankets with an alternate that would be less likely to propagate a fire. The FAA response is currently under Safety Board review.

[4] The description for this accident, DCA00MA079, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

visible, open flame. An off-duty AirTran pilot seated in first class considered using a Halon fire extinguisher but decided against it because he was concerned that the Halon "would take away more oxygen."

The Safety Board investigation of this accident is ongoing, but preliminary findings indicate that the smoke in the forward cabin was caused by electrical arcing in the bulkhead behind the captain's seat. The arcing ignited interior panels, which continued burning after the airplane landed and the passengers were evacuated. The fire was eventually extinguished by airport rescue and firefighting personnel.

American Airlines Flight 1683

On November 29, 2000, about 1753 eastern standard time, a McDonnell Douglas DC-9-82 (MD-80), N3507A, operated by American Airlines as flight 1683, was struck by lightning and experienced an in-flight fire that began shortly after takeoff from Reagan National Airport in Washington, D.C.[5] The flight crew performed an emergency landing and ordered a passenger evacuation at Dulles International Airport. The airplane sustained minor damage. None of the 2 pilots, 3 flight attendants, or 61 passengers were injured.

After takeoff, the three flight attendants saw a flash of light and heard a boom on the right side of the airplane. Flight attendant No. 1, who was seated on the forward jumpseat, saw white smoke coming from a fluorescent light fixture in the forward entry area. She shut the light off and called the cockpit. The captain told her to "pull the breaker" for the fluorescent light. She pulled the circuit breaker, and smoke stopped coming out of the fixture.

When flight attendant No. 1 went aft to check on the passengers, she observed "dark, dense, black" smoke coming from the ceiling panels above rows 7 and 8. She went to the cockpit and notified the flight crew while the other two flight attendants retrieved Halon fire extinguishers and brought them to the area near rows 7 and 8. The smoke detectors in the aft lavatories sounded. The smoke worsened in the midcabin area, and a ceiling panel above row 9 began to blister and turn yellow.

A flight attendant began discharging a Halon extinguisher toward the blistered ceiling panel. Flight attendant No. 1 asked the passengers if anyone had a knife that could be used to cut the ceiling panel. A passenger produced a knife and cut a circular hole in the blistered area of the ceiling panel. Flight attendant No. 1 then fully discharged a Halon fire extinguisher into the hole, assessed the results, and found that the smoke appeared to be diminishing. Before taking her seat for the emergency landing, another flight attendant gave the passenger in seat 9E a Halon fire extinguisher, instructed him on its use, and told him to "use it if it was needed." However, the smoke did not recur.

[5] The description for this accident, IAD01IA017, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

The Safety Board investigation of this incident is ongoing, but preliminary findings indicate that a lightning strike caused arcing in the airplane wiring above the cabin ceiling panels, which ignited adjacent materials.

1983 In-Flight Fire on Air Canada Flight 797

On June 2, 1983, about 1920 eastern daylight time, a McDonnell Douglas DC-9, C-FTLU, operated by Air Canada as flight 797, experienced an in-flight fire and made an emergency landing at the Greater Cincinnati International Airport (since renamed Cincinnati and Northern Kentucky International Airport) in Covington, Kentucky.[6] The fire was initially detected when a passenger noticed a strange smell and a flight attendant saw smoke in one of the lavatories. Another flight attendant saw that the smoke was coming from the seams between the walls and ceiling in the lavatory. Although neither flight attendant saw any flames, the second flight attendant discharged a CO_2 fire extinguisher into the lavatory, aiming at the paneling and seams and at the trash bin. He then closed the door. When the first officer came back to assess the situation, he found that the lavatory door was hot, and he instructed the flight attendants not to open it. The first officer then informed the captain that they "better go down," and an emergency descent was initiated.

During the descent, the smoke increased and moved forward in the cabin. After the airplane landed, flight attendants initiated an emergency evacuation. Of the 41 passengers and 5 crewmembers on board, 23 passengers were unable to evacuate and died in the fire. The airplane was destroyed.

In its final report, the Safety Board determined that the flight attendant's discharge of fire extinguishing agent into the lavatory "had little or no effect on the fire," noting that "[i]n order for the extinguishing agent to be effective, it must be applied to the base of the flames." The Board determined that the probable cause of the accident was "a fire of undetermined origin, an underestimate of fire severity, and conflicting fire progress information provided to the captain. Contributing to the severity of the accident was the flight crew's delayed decision to institute an emergency descent."[7]

As a result of the Air Canada accident, the Safety Board issued several recommendations to the Federal Aviation Administration (FAA), including Safety Recommendation A-83-70, which asked the FAA to expedite actions to require smoke detectors in lavatories; Safety Recommendation A-83-71, which asked the FAA to require the installation of automatic fire extinguishers adjacent to and in lavatory waste receptacles; and Safety Recommendation A-83-72, which asked the FAA to require that the hand-operated fire extinguishers carried aboard transport category airplanes use a technologically advanced agent, such as Halon. Recommendations A-83-70 and -72 were classified "Closed – Acceptable Action" and A-83-71

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[6] The description for this accident, DCA83AA028, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[7] National Transportation Safety Board, *Air Canada Flight 797, McDonnell Douglas DC-9-32, C-FTLU, Greater Cincinnati International Airport, Covington, Kentucky, June 2, 1983,* Aircraft Accident Report NTSB/AAR-84/09 (Washington, D.C.: NTSB, 1984).

was classified "Closed – Acceptable Alternate Action" on January 15, 1986, after the FAA completed rulemaking to require that all airplanes operated under 14 *Code of Federal Regulations* (CFR) Part 121 be equipped as follows: each lavatory and galley has a smoke or fire detector system that provides a warning light in the cockpit or an audio warning in the passenger cabin that would be readily detected by the flight attendant; each lavatory trash receptacle is equipped with a fire extinguisher that discharges automatically if a fire occurs in the receptacle; and, of the required hand-held fire extinguishers installed in the airplane, at least two contain Halon 1211 or equivalent as the extinguishing agent.

In its final report on the Air Canada accident, the Safety Board also issued Safety Recommendation A-84-76, which recommended that the FAA:

> Require that air carrier principal operations inspectors [POIs] review the training programs of their respective carriers and if necessary specify that they be amended to emphasize requirements: for flight crews to take immediate and aggressive action to determine the source and severity of any reported cabin fire and to begin an emergency descent for landing or ditching if the source and severity of the fire are not positively and quickly determined or if immediate extinction is not assured; for flight attendants to recognize the urgency of informing flight crews of the location, source, and severity of fire or smoke within the cabin; for both flight crews and flight attendants to be knowledgeable of the proper methods of aggressively attacking a cabin fire by including hands-on-training in the donning of protective breathing equipment, the use of the fire ax to gain access to the source of the fire through interior panels which can be penetrated without risk to essential aircraft components, and the discharge of an appropriate hand fire extinguisher on an actual fire.

In its November 2, 1984, response to the Safety Board, the FAA explained that 14 CFR 121.417 required crewmembers to be trained for fire emergencies and further required them to perform emergency drills and "actually operate the emergency equipment during initial and recurrent training for each type aircraft in which the crewmember is to serve." The FAA concluded that the regulations were adequate, stating that "the safety record of U.S. carriers is a testimony to the adequacy of the current regulations." In its April 12, 1985, letter, the Board disagreed, stating that "current firefighting training is directed primarily toward 'exposed' fires which are relatively easy to control. This does not prepare crews to assess effectively the hazard of or to fight hidden fires." The Board also reiterated its belief that crew training programs should emphasize that if the source of a fire cannot be immediately identified or cannot be extinguished immediately, the aircraft should be landed immediately. In its March 7, 1986, letter, the FAA responded that "due to requirements of 14 CFR 121.417, the various Air Carrier Operations Bulletins (ACOBs), and the guidance in the Air Carrier Operations Inspector's Handbook,"[8] further action by the FAA was unwarranted. The Safety Board disagreed and on May 12, 1986, classified Safety Recommendation A-84-76 "Closed – Unacceptable Action," stating that, "[a]lthough we have closed this recommendation, our concern for the safety issue

[8] See FAA Order 8430.6, *Air Carrier Operations Inspector's Handbook*.

involved has not diminished and we will continue to voice our concern in future accident investigations."

The Safety Board recognizes that the FAA's response to the Air Canada recommendations resulted in some changes that improved aircraft fire safety; in particular, requirements for smoke detectors and Halon-type fire extinguishers have provided crewmembers with better methods of locating and suppressing fires. However, the recent in-flight fires cited in this letter renew the Safety Board's interest in this issue and its concern that the FAA has not issued additional advisory material emphasizing the importance of training crewmembers to recognize, locate, and fight hidden fires on airplanes.

Safety Issues

Training

Title 14 CFR 121.417 requires that crewmembers receive training on firefighting equipment and procedures for fighting in-flight fires. The regulation specifies that airlines must provide individual instruction on, among other things, the location, function, and operation of portable fire extinguishers, with emphasis on the type of extinguisher to be used for different classes of fires and instruction on handling emergency situations, including fires that occur in flight or on the ground. As part of their initial training, each crewmember must accomplish a one-time emergency drill while fighting an actual fire[9] using the type of fire extinguisher that is appropriate for the type of fire being demonstrated in the drill.

Although 14 CFR 121.417 also requires crewmembers to perform certain drills biannually during recurrent training, including one that demonstrates their ability to operate each type of hand-operated fire extinguisher found on their airplanes, the regulation does not require recurrent training in fighting an actual or simulated fire. As a result, crewmembers are required to fight an actual or simulated fire during initial training only.

Further, although the emergency training requirements specified in 14 CFR 121.417 require instruction in fighting in-flight fires, they do not explicitly require that crewmembers be trained to identify the location of a hidden fire or to know how to gain access to the area behind interior panels. The Safety Board has evaluated the firefighting training programs of several air carriers and found that the actual "fire" crewmembers fight during initial training is typically an open flame that requires little effort to extinguish and that does not demonstrate the problems inherent in fighting a hidden fire on an airplane. AirTran's initial training program for flight attendants, for example, includes a firefighting drill in which students are required to extinguish an actual fire consisting of a visible, open flame. The accident and incident descriptions in this letter demonstrate that in-flight fires on commercial airplanes can present themselves not as visible, localized flames, but in less obvious ways, such as smoke or heat from hidden locations. Crewmembers must be trained to quickly identify the location of the fire, which may require

[9] Title 14 CFR 121.417 provides a definition of an actual fire: "An *actual fire* means an ignited combustible material, in controlled conditions, of sufficient magnitude and duration to accomplish the training objectives."

removing interior panels or otherwise accessing the areas behind the panels before they can use fire extinguishers effectively.

The results of a series of experiments conducted by the FAA Technical Center[10] to evaluate the ability of flight attendants to extinguish cargo fires in small Class B cargo compartments also demonstrate that the FAA's current training requirements are inadequate. Technical Center staff conducted 13 tests in which trained crewmembers attempted to extinguish cargo fires located in a cabin-level compartment using firefighting equipment identical to the types on which they had been trained. The report noted that, although the fires could have been extinguished using proper techniques, in most cases the crewmembers did not act quickly or aggressively enough to successfully extinguish the fires. The report concludes that "improved and more realistic training procedures would better prepare flight attendants to more effectively fight in-flight fires."

The Safety Board is concerned that as a result of limited training, crewmembers may fail to take immediate and aggressive action in locating and fighting in-flight fires, as demonstrated in the events cited in this letter. In the Delta flight 2030 incident, the flight attendant asked for the captain's permission before discharging a fire extinguisher. This delayed an immediate firefighting response. Further, if the captain's order not to use the fire extinguisher had been carried out, the fire would likely have progressed and could have resulted in death or serious injury, as well as possible loss of the airplane. In the AirTran flight 913 accident, flight attendants made no effort to locate the source of the smoke or to use any of the firefighting equipment available to them. In the American flight 1683 incident, a flight attendant, working with a passenger, successfully extinguished the fire by cutting a hole in the overhead panel and applying extinguishing agent. Although this action was successful, the Board notes that the flight attendant took the action on her own initiative, not because she was trained to do so. In the Air Canada accident, flight attendants did not apply extinguishing agent directly to the flames, either because they had not been trained to do so or because they could not access the area behind the interior panels.

The Safety Board concludes that current training programs still do not adequately prepare crewmembers to fight the type of hidden in-flight fires likely to occur on airplanes. Therefore, the Board believes that the FAA should issue an advisory circular (AC) that describes the need for crewmembers to take immediate and aggressive action in response to signs of an in-flight fire. The AC should stress that fires often are hidden behind interior panels and therefore may require a crewmember to remove or otherwise gain access to the area behind interior panels in order to effectively apply extinguishing agents to the source of the fire. Further, the Board believes that the FAA should require POIs to ensure that the contents of the AC are incorporated into crewmember training programs. Finally, the Board believes that the FAA should amend 14 CFR 121.417 to require participation in firefighting drills that involve actual or simulated fires during crewmember recurrent training and to require that those drills include realistic scenarios on recognizing potential signs of, locating, and fighting hidden fires.

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[10] See U.S. Department of Transportation, Federal Aviation Administration, *Effectiveness of Flight Attendants Attempting to Extinguish Fires in an Accessible Cargo Compartment,* DOT/FAA/AR-TN99/29 (April 1999).

Access to Areas Behind Interior Panels

The Safety Board is also concerned that the interior panels of airplanes are not designed so that crewmembers are able to easily and quickly locate and extinguish hidden in-flight fires. The Board addressed this problem in 1983 after the Air Canada accident, in which one flight attendant discharged a CO_2 extinguisher into the lavatory, aiming at the seams between the walls and the ceiling where smoke had been observed. The Board found that this action had little effect on the fire because the extinguishing agent was not applied to the source of the fire. In the American incident, the flight attendant did access the area behind the ceiling panel, but the method used (that is, having a passenger cut a hole in the ceiling) risked damage to electrical wiring and other cables that may have been covered by the paneling. In addition, although the flight attendant's action successfully extinguished the fire, access to the area behind the panel should not have been dependent on the actions of a passenger, either to provide a sharp instrument for cutting or to cut the hole itself.

Therefore, the Safety Board believes that the FAA should develop and require implementation of procedures or airplane modifications that will provide the most effective means for crewmembers to gain access to areas behind interior panels for the purpose of applying extinguishing agent to hidden fires. As part of this effort, the FAA should evaluate the feasibility of equipping interior panels of new and existing airplanes with ports, access panels, or some other means to apply extinguishing agent behind interior panels.

Properties of Halon and the Merits of Halon Extinguishers in Fighting In-Flight Fires

The Safety Board is concerned that, in two of the occurrences described in this letter, crewmembers hesitated to use Halon extinguishers. In the Delta incident, the captain specifically ordered a flight attendant not to use the Halon extinguisher because he was concerned about Halon being sprayed in the cabin. In the AirTran accident, an off-duty crewmember chose not to use the Halon extinguisher because of his concern that it "would take away more oxygen" from the cabin.

FAA AC 20-42C, *Hand Fire Extinguishers for Use in Aircraft*, states that Halon-type extinguishers are three times as effective as CO_2 extinguishers with the same weight of extinguishing agent, have a gaseous discharge and therefore a more limited throw range, leave no chemical residue to contaminate or corrode aircraft parts or surfaces, have fewer adverse effects on electronic equipment, and do not degrade visual acuity. However, AC 20-42C also states the following:

> Tests indicate that human exposure to high levels of Halon vapors may result in dizziness, impaired coordination, and reduced mental sharpness. . . . Exposure to undecomposed halogenated agents may produce varied central nervous system effects depending upon exposure concentration and time. Halogenated agents will also decompose into more toxic products when subjected to flame or hot surfaces

at approximately 900º F (482º C). However, unnecessary exposure of personnel to either the natural agent or to the decomposition products should be avoided.

The AC also specifies maximum concentration levels for Halon agents under various conditions that should not be exceeded in ventilated and non-ventilated passenger compartments on aircraft. It appears that air carrier training programs may not be placing enough emphasis on the importance of using Halon extinguishers to fight in-flight fires and may not make it clear that the maximum allowable levels of Halon vapors cannot be achieved by discharging a single hand-held extinguisher in a transport-sized cabin.

Although the AC also states, "generally, the decomposition products from the fire itself, especially carbon monoxide, smoke, heat, and oxygen depletion, create a greater hazard than the thermal decomposition products from Halon," the Safety Board is concerned that the potential hazards posed by Halon gas are over-emphasized in the AC, especially when compared to the potentially devastating effects of an in-flight fire. Indeed, the statement quoted above is buried in the paragraph warning against exposure to Halon gas.

The Safety Board therefore believes that the FAA should issue a flight standards handbook bulletin to POIs to ensure that air carrier training programs explain the properties of Halon and emphasize that the potential harmful effects on passengers and crew are negligible compared to the safety benefits achieved by fighting in-flight fires aggressively.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an advisory circular (AC) that describes the need for crewmembers to take immediate and aggressive action in response to signs of an in-flight fire. The AC should stress that fires often are hidden behind interior panels and therefore may require a crewmember to remove or otherwise gain access to the area behind interior panels in order to effectively apply extinguishing agents to the source of the fire. (A-01-83)

Require principal operations inspectors to ensure that the contents of the advisory circular (recommended in A-01-83) are incorporated into crewmember training programs. (A-01-84)

Amend 14 *Code of Federal Regulations* 121.417 to require participation in firefighting drills that involve actual or simulated fires during crewmember recurrent training and to require that those drills include realistic scenarios on recognizing potential signs of, locating, and fighting hidden fires. (A-01-85)

Develop and require implementation of procedures or airplane modifications that will provide the most effective means for crewmembers to gain access to areas behind interior panels for the purpose of applying extinguishing agent to hidden fires. As part of this effort, the FAA should evaluate the feasibility of equipping

interior panels of new and existing airplanes with ports, access panels, or some other means to apply extinguishing agent behind interior panels. (A-01-86)

Issue a flight standards handbook bulletin to principal operations inspectors to ensure that air carrier training programs explain the properties of Halon and emphasize that the potential harmful effects on passengers and crew are negligible compared to the safety benefits achieved by fighting in-flight fires aggressively. (A-01-87)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred with these recommendations.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 22, 2002

In reply refer to: H-01-39 through -41

Honorable Jeffrey W. Runge
Administrator
National Highway Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

On March 28, 2000, about 6:40 a.m. (sunrise was at 6:33 a.m.), a CSX Transportation, Inc., (CSXT) freight train traveling 51 mph struck the passenger side of a Murray County, Georgia, School District school bus at a railroad/highway grade crossing near Conasauga, Tennessee.[1] The accident occurred as the school bus was crossing the tracks at a speed of approximately 15 mph. During the accident sequence, the driver and three children were ejected. Two ejected passengers received serious injuries and one was fatally injured. The driver, who had been wearing a lap/shoulder belt that broke during the crash sequence, received minor injuries. Of the four passengers who remained inside the bus, two were fatally injured, one sustained serious injuries, and one, who was restrained by a lap belt, received minor injuries. The two train crewmembers were not injured.

One safety issue examined by the National Transportation Safety Board in its investigation of this accident was the busdriver's ability to hear the train horn. Locomotive event recorder data from the train involved in the Conasauga accident indicate that the train horn was activated for about 3 seconds when the train was 952 feet from the crossing and then continuously for 9 seconds (a minimum of 574 feet) before the collision. The busdriver had the radio on, and a speaker was positioned above her head. Additionally, the two panels above the driver's head were covered with sound attenuation material.[2]

With the door closed and the radio on (the conditions at the time of the accident), audibility testing revealed that the sound of the horn was only 4 decibels greater than the ambient

[1] For more information, read: National Transportation Safety Board, *Collision of CSXT Freight Train and Murray County, Georgia, School District School Bus at Railroad/Highway Grade Crossing in Conasauga, Tennessee, on March 28, 2000,* Highway Accident Report NTSB/HAR-01/03 (Washington, DC: NTSB, 2001).

[2] While it is unclear how much this material contributed to the driver's inability to hear the train horn, it may have absorbed some of the horn sound. The Safety Board remains concerned about the effects of sound attenuation material on a driver's ability to hear an alerting signal. As explained in the Fox River Grove, Illinois, report, sound attenuation material reduced the volume of both the train horn and the warnings shouted by bus passengers in that accident. For more information, read: National Transportation Safety Board, *Collision of Northeast Illinois Regional Commuter Railroad Corporation (METRA) Train and Transportation Joint Agreement School District 47/155 School Bus at Railroad/Highway Grade Crossing in Fox River Grove, Illinois, on October 25, 1995,* Highway/Railroad Accident Report NTSB/HAR-96/02 (Washington, DC: NTSB, 1996).

noise when the train was 1,268 feet from the crossing; the horn was barely detectable to a volunteer busdriver. To be identified, a sound must be 3 to 9 decibels above the threshold of detection;[3] to reach the alerting level, it must be at least 10 decibels above the ambient noise level.[4] Since the sound level increases by about 6 decibels when the distance is halved, at 574 feet (the point where the horn was sounded continuously), the sound of the horn would have been about 11 decibels above the threshold of ambient noise. During the accident sequence, with the radio on and the door and window closed, the audio portion of the videotape did not pick up the sound of the horn over the ambient noise. During testing, with the radio off and the door open, even at 1,268 feet, the sound level of the horn was 25 decibels above that of the ambient noise, and a driver would probably be able to detect the sound and be alerted to the approaching train. Therefore, the Safety Board concluded that the driver did not stop, had the radio on, and the door closed; thus she had difficulty detecting the train horn and was probably unaware of the presence of the train.

The Safety Board made two recommendations concerning bus speakers to the National Association of State Directors of Pupil Transportation Services (NASDPTS) in the 1996 Fox River Grove, Illinois, highway accident report:[5]

> H-96-50
> Develop guidelines for the appropriate placement of radio speakers and use of radios on school buses and disseminate these guidelines to your members.
>
> H-96-51
> Advise your members to check their school district buses and disable any radio speakers located immediately adjacent to the school bus drivers' heads.

The NASDPTS informed the Safety Board that it had surveyed the States and found that a majority of the States had prohibited, or had legislation pending that prohibited, radio speakers in the driver's compartment. The remaining States reviewed their policies on use of radios and radio speakers in school buses and stated that the policies were adequate to ensure that drivers can hear critical auditory information. Georgia informed its local school districts of the need to follow proper procedures, including turning off speakers, when crossing railroad tracks. The State did not require school districts to disconnect the speakers adjacent to the driver's head; Georgia left that decision to the local school districts. In October 1998, the National Safety Council revised its "Recommended Procedures for School Bus Drivers at Railroad Grade Crossings" to remind drivers of the importance of turning off radios at railroad/highway grade crossings; the revision was incorporated in the *2000 National School Transportation Specifications and Procedures*. Based on the NASDPTS survey and the association's efforts to inform its members of the hazards of not turning off the radio at grade crossings, Safety

[3] The "threshold of detection" is the level at which a person is aware of a sound.

[4] For more information, read: Stanley C. Skeiber, Robert L. Mason, and R. C. Potter "Effectiveness of Audible Warning Devices on Emergency Vehicles, Sound and Vibration," February 1978, pp. 14-22.

[5] For more information, read: NTSB/HAR-96/02.

Recommendations H-96-50 and –51 were classified "Closed—Acceptable Alternate Action"[6] on February 19, 1999.

Despite the NASDPTS' efforts, the 1-year-old school bus involved in this accident was equipped with a radio speaker adjacent to the driver's head. Speakers adjacent to a school bus driver's head probably contribute the most to masking exterior sounds, such as train horns, but air conditioning, heaters, defrosters, wiper motors, and other sounds also help mask exterior sounds. In addition, to exacerbate the audibility problem, the driver in the Conasauga accident did not follow prescribed policy to turn down the volume at railroad/highway grade crossings. The Safety Board understands from the NASDPTS' response to Safety Recommendations H-96-50 and -51 that the speakers are also used to transmit important information to the driver via two-way radio from the school district dispatcher. While the Safety Board agrees that information from the dispatcher is important, use of the speakers for music or entertainment broadcasts is not critical and can hamper the driver's ability to hear external auditory alerts.

The Safety Board also examined passenger survivability during its investigation of this accident. In this accident, as well as other school bus accidents the Safety Board has investigated, passengers sustained serious or fatal injuries due to impact with sidewall components. The unrestrained passengers on the driver side of the bus in this accident were propelled out of their seating compartment and received serious or fatal injuries as a result of such impacts. In several accidents discussed in the Safety Board's *Bus Crashworthiness Issues* report (Holmdel, New Jersey; Monticello, Minnesota; and Easton, Maryland),[7] passengers away from the impact area were also propelled laterally out of their seating compartments and sustained serious and fatal injuries due to contacting non-energy absorbing surfaces.

Even passengers seated on the same side as, but not in, the area of impact (such as the passenger in the first row in this accident), have struck non-energy absorbing sidewalls and components during a collision. In the Fox River Grove accident,[8] a passenger seated away from the impact area but on the same side of the bus as the impact sustained a fatal head injury and an abrasion across the forehead that matched the perforated sound panel pattern on the upper left side of the bus interior. The Safety Board concluded that even those passengers who are outside the area of impact and remain within their compartments can receive serious or fatal injuries due to impact with non-energy absorbing components within a school bus.

Sidewall components, such as window frames, screws and joints, and overhead storage rack supports are located throughout the interior of the passenger compartment, as are the sides of the seat frames,[9] yet are exempt from the *Federal Motor Vehicle Safety Standards* for passenger protection in school buses. Although energy-absorbing materials on the window frames, sidewall panels, roof racks, sides of seat frames and modesty panels might benefit

[6] The recommendations received this classification because the actions taken met the intent of the recommendations, even though formal guidelines were not developed, and school districts were reminded of the hazards of speaker use when approaching railroad tracks, but were not specifically told to disable the speakers.

[7] For more information, read: National Transportation Safety Board, *Bus Crashworthiness Issues*. Highway Special Investigation Report NTSB/SIR-99/04 (Washington, DC: NTSB, 1999).

[8] For more information, read: NTSB/HAR-96/02.

[9] Or in the case of the first row in this accident, the modesty panels.

passengers who impact these locations, school bus passengers are not afforded the benefit of energy-absorbing surfaces on these structures and components. If these components were included in the passenger protection requirements of Federal Motor Vehicle Safety Standard 222, "School Bus Passenger Seating and Crash Protection," passenger injuries would probably be mitigated. The Safety Board concluded that Federal Motor Vehicle Safety Standard 222 exempts sidewall components and sides of seat frames within the passenger compartment of school buses, thereby exposing passengers to these injury-producing components in lateral impact collisions.

Another safety issue highlighted by the circumstances of this accident was the benefit of automatic crash notification (ACN) systems. This particular accident was reported in a timely manner due to prompt action by a passerby familiar with the accident area. However, the outcome could have been less timely because the accident occurred in a rural area where traffic is not heavy. An ACN system on the school bus would have detected the crash immediately and transmitted the crash information, as well as the precise location, obtained via a global positioning system, to the local 911 center. Had such a system been in place, the school bus passengers would not have had to rely on a passerby to place the call or on the driver, who was incapacitated, to call 911. In this accident, the locomotive conductor notified CSXT of the accident, and CSXT then notified the 911 center; but not all accidents involve vehicles in which the driver (or in this case the train crew) is able to place an emergency call.

Because school buses often carry many children, quick and adequate emergency response is important if all children are to be treated expeditiously, particularly those with serious injuries. The more information provided to an emergency dispatch center, the better the response is likely to be. An ACN system can transmit information on the severity of the crash, the vehicle dynamics, and the location. Some systems include a voice communication line that automatically opens so that the emergency response center can communicate directly with the driver, if the driver is capable. If the school bus in this accident had been equipped with an ACN system, a call would have immediately been forwarded to the 911 center, either directly or through a relay center, and the 911 dispatcher would have known the exact location of the accident. A more advanced ACN system would have relayed information about the severity of the crash, indicating to the dispatcher a need to send multiple responders. The time lag would most likely have been less than 2 minutes from the time of the collision to the time when emergency response was dispatched.

Currently available ACN systems have helped reduce emergency response time, thereby leading to more lives saved.[10] In an operational test in New York, emergency notification was sent to the sheriff's office within 2 minutes of the accidents that occurred.[11] Cellular telephone system coverage has expanded and geolocation systems have become more accurate; as a result, ACN system accuracy has improved. While the school bus passengers in this accident were fortunate in the actions of a quick-thinking passerby and a train crew that was able to place an

[10] For more information, read: W. Evanco "Reducing Accident Fatalities with Rural Mayday Systems," Mitretek Systems, Inc. WN96W0000048, April 1996, in U.S. Department of Transportation, Federal Highway Administration, *Review of ITS Benefits: Emerging Successes*, FHWA-JPO-97-001, HVH 1/10-96(1M0) E (Washington, DC: FHWA) 19.

[11] For more information, read: B. Donnelly, D. Schabel, A.J. Blatt, and A. Carter, "The Automated Collision Notification System," *International Symposium on Transportation Recorders, May 3-5, 1999* (Washington, DC: National Transportation Safety Board and International Transportation Safety Association, 1999).

emergency call, severe accidents, particularly in rural areas, do not always occur in such circumstances.

In such situations, ACN systems can help emergency call centers dispatch emergency responders to locations more expeditiously, particularly in rural areas or when drivers are incapacitated. The Safety Board concluded that, given the limited amount of traffic traversing Liberty Church Road, emergency response might have been delayed if the passerby had not noticed the accident or if the train crew had been incapacitated. While ACN systems are already available on cars, testing of such systems on school buses has yet to be done. While the cellular technology would be compatible with any vehicle, testing of ACN systems on school buses is needed to evaluate factors such as vehicle dynamics and crash severity.

Therefore, the National Transportation Safety Board recommends the National Highway Traffic Safety Administration:

> Implement rulemaking to prohibit radio speakers used for music or entertainment from being placed adjacent to drivers' heads in school buses. (H-01-39)
>
> Develop and incorporate into the *Federal Motor Vehicle Safety Standards* performance standards for school buses that address passenger protection for sidewalls, sidewall components, and seat frames. (H-01-40)
>
> Evaluate the feasibility of incorporating automatic crash notification systems on school buses and, if feasible, proceed with system development. (H-01-41)

The Safety Board also issued safety recommendations to the States, the Federal Highway Administration, the Georgia Department of Education, the National Association of State Directors of Pupil Transportation Services, and the school bus manufacturers. The Safety Board also reiterated a recommendation to the U.S. Department of Transportation.

Please refer to Safety Recommendations H-01-39 through -41 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 22, 2002

In reply refer to: H-01-42

Honorable Mary E. Peters
Administrator
Federal Highway Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

On March 28, 2000, about 6:40 a.m., a CSX Transportation, Inc., (CSXT) freight train traveling 51 mph struck the passenger side of a Murray County, Georgia, School District school bus at a railroad/highway grade crossing near Conasauga, Tennessee.[1] The accident occurred as the school bus was crossing the tracks at a speed of approximately 15 mph. During the accident sequence, the driver and three children were ejected. Two ejected passengers received serious injuries and one was fatally injured. The driver, who had been wearing a lap/shoulder belt that broke during the crash sequence, received minor injuries. Of the four passengers who remained inside the bus, two were fatally injured, one sustained serious injuries, and one, who was restrained by a lap belt, received minor injuries. The two train crewmembers were not injured.

In reviewing documents pertaining to Murray County school bus routes, National Transportation Safety Board investigators determined that route hazards, including grade crossings, apparently were not identified, nor were busdrivers told (other than through annual training) what actions to take in the area of potential hazards. The Murray County transportation director has stated that all routes have been reviewed since the accident and, as necessary, rerouted to use gated railroad crossings. The routes were also reviewed and, as appropriate, adjusted for other hazards, such as unsafe turns, curves, and pick-up and drop-off locations.

To assist the States in assessing grade crossing safety, the Federal Railroad Administration (FRA) compiles and maintains the U.S. Department of Transportation's (DOT's) Highway Rail Crossing Inventory.[2] In examining the database, the Safety Board found discrepancies between information contained in the database and existing conditions at the accident crossing and other crossings in the area. Investigators looked at 10 crossings in the Liberty Church Road vicinity and found that the inventory listed the track speed as 10 mph less than the actual speed in seven instances and did not list the track speed at all in one instance. The

[1] For more information, read: National Transportation Safety Board, *Collision of CSXT Freight Train and Murray County, Georgia, School District School Bus at Railroad/Highway Grade Crossing in Conasauga, Tennessee, on March 28, 2000,* Highway Accident Report NTSB/HAR-01/03 (Washington, DC: NTSB, 2001).

[2] Database intended to document every grade crossing in the United States <http://safetydata.fra.dot.gov/officeofsafety/Crossing/Default.asp>.

inventory listed 13 trains per day for five crossings, 16 trains per day for four crossings, and did not list the number of trains for one crossing. CSXT reported 30 to 35 trains traveling over each crossing daily.

States often use information from the inventory to develop a hazard index for railroad/highway grade crossings. The FRA developed a Web-based Accident Prediction System (WBAPS) that is based, in part, on information from the inventory, including data such as the type of warning device at the grade crossing, the exposure index,[3] and the number of accidents at the location in the past 5 years. A private company, under contract to the FRA, completed an analysis of the WBAPS in June 1999, comparing the performance of the FRA model to other models used to predict accidents. The study found that differences were minimal and that no model retained a substantial edge over another.[4] The public can use the WBAPS to help determine where best to direct highway grade crossing resources.[5] Law enforcement personnel can use the system to target unsafe crossings for monitoring.

The FRA maintains the nationwide grade crossing inventory. As part of the 1998 passive grade crossing study, the Safety Board made the following recommendation concerning this system:

> R-98-41
> Modify the grade crossing inventory system to include information on (1) the sight distances available to a motorist, and (2) the presence of curves on the roadway and on the tracks. Direct the States to include these data as a part of the regularly scheduled updates of the database.

Because the FRA updated the grade crossing inventory database to include recommended elements, on January 4, 2000, the Safety Board classified Safety Recommendation R-98-41 "Closed—Acceptable Action." However, as Safety Board investigators discovered, some information in the inventory is still outdated and incorrect. Of 10 sites in the area of the accident crossing surveyed by Safety Board investigators, the inventory listed incorrect maximum train speeds for 8 and incorrect number of trains per day for all 10.

In its April 6, 1999, response to Safety Recommendation R-98-41, the FRA stated that such discrepancies occur because updating the information is voluntary and the FRA lacks the authority to require States or railroads to upgrade information in the inventory. The FRA has encouraged the States to provide up-to-date information for the inventory, but the States have not done so. The Federal Highway Administration gives funds to the States annually for highway safety, including grade crossing safety, and provision of these funds could be contingent on updating the inventory regularly.

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[3] The exposure index includes the number of trains per day, the number of cars traversing the grade crossing, and the fastest train speed on the track.

[4] May 8, 2000, letter from the Secretary of Transportation to the Chairman of the National Transportation Safety Board.

[5] U.S. Department of Transportation, Federal Railroad Administration, "Using Data Produced by WBAPS Disclaimer."

Because the States and others rely on this inventory for determining hazards and predicting accidents at grade crossings, inaccurate information can lead to invalid assessments. For example, the inventory lists the Liberty Church Road crossing as having 13 trains per day at a speed of 50 mph, which underestimates the 30 to 35 trains per day passing through at a maximum of 60 mph. When these underestimates are factored into equations that help users determine relative hazards, the resulting hazard index is similarly understated and hazardous grade crossings may not be recognized as such. The Safety Board concluded that though critical to assessing grade crossing hazards, the data in the Highway-Rail Grade Crossing Inventory are not always accurate and complete. Therefore, the National Transportation Safety Board recommends that the Federal Highway Administration:

> Require States to update the Highway-Rail Crossing Inventory to accurately reflect current railroad operations. (H-01-42)

The Safety Board also issued safety recommendations to the States, the National Highway Traffic Safety Administration, the Georgia Department of Education, the National Association of State Directors of Pupil Transportation Services, and the school bus manufacturers. The Safety Board also reiterated a recommendation to the U.S. Department of Transportation.

Please refer to Safety Recommendation H-01-42 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 22, 2002

In reply refer to: H-01-43

Mrs. Linda C. Schrenko
State Superintendent of Schools
Georgia Department of Education
2066 Twin Towers East
Atlanta, Georgia 30334-5001

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses disconnecting radio speakers used for music or entertainment on school buses to enhance school bus safety at passive grade crossings. The recommendation is derived from the Safety Board's investigation of the collision of a CSX Transportation, Inc., (CSXT) freight train and Murray County, Georgia, district school bus at a railroad/highway grade crossing in Conasauga, Tennessee, on March 28, 2000,[1] and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has reiterated 1 safety recommendation and issued 10 new safety recommendations, 1 of which is addressed to the Georgia Department of Education. Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

On March 28, 2000, about 6:40 a.m. (sunrise was at 6:33 a.m.), a CSXT freight train traveling 51 mph struck the passenger side of a Murray County, Georgia, School District school bus at a railroad/highway grade crossing near Conasauga, Tennessee. The accident occurred as the school bus was crossing the tracks at a speed of approximately 15 mph. During the accident sequence, the driver and three children were ejected. Two ejected passengers received serious injuries and one was fatally injured. The driver, who had been wearing a lap/shoulder belt that broke during the crash sequence, received minor injuries. Of the four passengers who remained inside the bus, two were fatally injured, one sustained serious injuries, and one, who was restrained by a lap belt, received minor injuries. The two train crewmembers were not injured.

[1] For more information, read: National Transportation Safety Board, *Collision of CSXT Freight Train and Murray County, Georgia, School District School Bus at Railroad/Highway Grade Crossing in Conasauga, Tennessee, on March 28, 2000,* Highway Accident Report NTSB/HAR-01/03 (Washington, DC: NTSB, 2001).

Locomotive event recorder data from the train involved in the Conasauga accident indicate that the train horn was activated for about 3 seconds when the train was 952 feet from the crossing and then continuously for 9 seconds (a minimum of 574 feet) before the collision. The busdriver had the radio and overhead speaker on. Additionally, the two panels above the driver's head were covered with sound attenuation material.[2]

With the door closed and the radio on (the conditions at the time of the accident), audibility testing revealed that the sound of the horn was only 4 decibels greater than the ambient noise when the train was 1,268 feet from the crossing; the horn was barely detectable to a volunteer busdriver. To be identified, a sound must be 3 to 9 decibels above the threshold of detection;[3] to reach the alerting level, it must be at least 10 decibels above the ambient noise level.[4] Since the sound level increases by about 6 decibels when the distance is halved, at 574 feet (the point where the horn was sounded continuously), the sound of the horn would have been about 11 decibels above the threshold of detection. During the accident sequence, with the radio on and the door and window closed, the audio portion of the videotape did not pick up the sound of the horn over the ambient noise. During testing, with the radio off and the door open, even at 1,268 feet, the sound level of the horn was 25 decibels above that of the ambient noise, and a driver would probably be able to detect the sound and be alerted to the approaching train. Therefore, the Safety Board concluded that the driver did not stop, had the radio on, and the door closed; thus she had difficulty detecting the train horn and was probably unaware of the presence of the train.

The Safety Board made two recommendations concerning bus speakers to the National Association of State Directors of Pupil Transportation Services (NASDPTS) in the 1996 Fox River Grove, Illinois, highway accident report:[5]

> H-96-50
> Develop guidelines for the appropriate placement of radio speakers and use of radios on school buses and disseminate these guidelines to your members.
>
> H-96-51
> Advise your members to check their school district buses and disable any radio speakers located immediately adjacent to the school bus drivers' heads.

The NASDPTS informed the Safety Board that it had surveyed the States and found that a majority of the States had prohibited, or had legislation pending that prohibited, radio speakers in

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[2] While it is unclear how much this material contributed to the driver's inability to hear the train horn, it may have absorbed some of the horn sound. The Safety Board remains concerned about the effects of sound attenuation material on a driver's ability to hear an alerting signal. As explained in the Fox River Grove, Illinois, report, sound attenuation material reduced the volume of both the train horn and the warnings shouted by bus passengers in that accident. For more information, read: National Transportation Safety Board, *Collision of Northeast Illinois Regional Commuter Railroad Corporation (METRA) Train and Transportation Joint Agreement School District 47/155 School Bus at Railroad/Highway Grade Crossing in Fox River Grove, Illinois, on October 25, 1995,* Highway/Railroad Accident Report NTSB/HAR-96/02 (Washington, DC: NTSB, 1996).

[3] The "threshold of detection" is the level at which a person is aware of a sound.

[4] Stanley C. Skeiber, Robert L. Mason, and R. C. Potter "Effectiveness of Audible Warning Devices on Emergency Vehicles, Sound and Vibration," February 1978, pp. 14-22.

[5] NTSB/HAR-96/02.

the driver's compartment. The remaining States reviewed their policies on use of radios and radio speakers in school buses and stated that the policies were adequate to ensure that drivers can hear critical auditory information. Georgia informed its local school districts of the need to follow proper procedures, including turning off speakers, when crossing railroad tracks. The State did not require school districts to disconnect the speakers adjacent to the driver's head; Georgia left that decision to the local school districts. In October 1998, the National Safety Council revised its "Recommended Procedures for School Bus Drivers at Railroad Grade Crossings" to remind drivers of the importance of turning off radios at railroad/highway grade crossings; the revision was incorporated in the *2000 National School Transportation Specifications and Procedures*. Based on the NASDPTS survey and the association's efforts to inform its members of the hazards of not turning off the radio at grade crossings, Safety Recommendations H-96-50 and –51 were classified "Closed—Acceptable Alternate Action"[6] on February 19, 1999.

Despite the NASDPTS' efforts, the 1-year-old school bus involved in this accident was equipped with a radio speaker adjacent to the driver's head. Speakers adjacent to a school bus driver's head probably contribute the most to masking exterior sounds, such as train horns, but air conditioning, heaters, defrosters, wiper motors, and other sounds also help mask exterior sounds. In addition, to exacerbate the audibility problem, the driver in the Conasauga accident did not follow prescribed policy to turn down the volume at railroad/highway grade crossings. The Safety Board understands from the NASDPTS' response to Safety Recommendations H-96-50 and -51 that the speakers are also used to transmit important information to the driver via two-way radio from the school district dispatcher. While the Safety Board agrees that information from the dispatcher is important, use of the speakers for music or entertainment broadcasts is not critical and can hamper the driver's ability to hear external auditory alerts. Therefore, the National Transportation Safety Board recommends that the Georgia Department of Education:

> Require all school districts to disconnect radio speakers used for music or entertainment that are adjacent to school bus drivers' heads. (H-01-43)

The Safety Board also issued safety recommendations to the States, the National Highway Traffic Safety Administration, the Federal Highway Administration, the National Association of State Directors of Pupil Transportation Services, and the school bus manufacturers. The Safety Board also reiterated a recommendation to the U.S. Department of Transportation. In your response to the recommendation in this letter, please refer to H-01-43. If you need additional information, you may call (202) 314-6607.

[6] The recommendations received this classification because the actions taken met the intent of the recommendations, even though formal guidelines were not developed, and school districts were reminded of the hazards of speaker use when approaching railroad tracks, but were not specifically told to disable the speakers.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 22, 2002

In reply refer to: H-01-44 through -46

Mr. Charlie Gauthier
Executive Director
National Association of State Directors of Pupil Transportation Services
1604 Longfellow Street
McLean, Virginia 22101

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

These recommendations address initiatives to enhance school bus and passive grade crossing safety and the safety consequences of large longitudinal distances between lap/shoulder belt anchor points. The recommendations are derived from the Safety Board's investigation of the Safety Board's investigation of the collision of a CSX Transportation, Inc., (CSXT) freight train and Murray County, Georgia, district school bus at a railroad/highway grade crossing in Conasauga, Tennessee, on March 28, 2000,[1] and are consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued reiterated 1 safety recommendation and issued 10 new safety recommendations, 3 of which are addressed to the National Association of State Directors of Pupil Transportation Services (NASDPTS). Information supporting the recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

On March 28, 2000, about 6:40 a.m., a CSXT freight train traveling 51 mph struck the passenger side of a Murray County, Georgia, School District school bus at a railroad/highway grade crossing near Conasauga, Tennessee. The accident occurred as the school bus was crossing the tracks at a speed of approximately 15 mph. During the accident sequence, the driver and three children were ejected. Two ejected passengers received serious injuries and one was fatally injured. The driver, who had been wearing a lap/shoulder belt that broke during the crash sequence, received minor injuries. Of the four passengers who remained inside the bus, two were

[1] For more information, read: National Transportation Safety Board, *Collision of CSXT Freight Train and Murray County, Georgia, School District School Bus at Railroad/Highway Grade Crossing in Conasauga, Tennessee, on March 28, 2000,* Highway Accident Report NTSB/HAR-01/03 (Washington, DC: NTSB, 2001).

fatally injured, one sustained serious injuries, and one, who was restrained by a lap belt, received minor injuries. The two train crewmembers were not injured.

During its investigation of the Conasauga accident, the Safety Board determined, after reviewing documents pertaining to Murray County school bus routes, that route hazards, including grade crossings, apparently were not identified, nor were busdrivers told (other than through annual training) what actions to take in the area of potential hazards. As a result of a previous accident investigation involving similar issues,[2] the Safety Board recommended that the NASDPTS:

> H-96-52
> Encourage your members to develop and implement a program for the identification of school bus route hazards and to routinely monitor and evaluate all regular and substitute school bus drivers.

In June 1998, the NASDPTS, in cooperation with the National Highway Traffic Safety Administration, published guidance on school bus routing and distributed the guidance to States and localities. The Safety Board classified Safety Recommendation H-96-52 "Closed—Acceptable Action" on November 7, 1997. The guidance is also now part of the *National School Transportation Specifications and Procedures.*

To further assist the States in assessing grade crossing safety, the Federal Railroad Administration (FRA) compiles and maintains the U.S. Department of Transportation's (DOT's) Highway Rail Crossing Inventory.[3] States often use information from the inventory to develop a hazard index for railroad/highway grade crossings. The FRA developed a Web-based Accident Prediction System (WBAPS) that is based, in part, on information from the inventory, and on data such as the type of warning device at the grade crossing, the exposure index,[4] and the number of accidents at the location in the past 5 years. A private company, under contract to the FRA, completed an analysis of the WBAPS in June 1999, comparing the performance of the FRA model to other models used to predict accidents. The study found that differences were minimal and that no model retained a substantial edge over another.[5] The public can use the WBAPS to help determine where best to direct highway grade crossing resources.[6] Law enforcement personnel can use the system to target unsafe crossings for monitoring.

According to an FRA official, about half the States have devised their own hazard indexes for evaluating grade crossings. Tennessee uses the DOT's *Rail Highway Crossing*

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[2] For more information, read: National Transportation Safety Board, *Collision of Northeast Illinois Regional Commuter Railroad Corporation (METRA) Train and Transportation Joint Agreement School District 47/155 School Bus at Railroad/Highway Grade Crossing in Fox River Grove, Illinois, on October 25, 1995,* Highway/Railroad Accident Report NTSB/HAR-96/02 (Washington, DC: NTSB, 1996).

[3] Database intended to document every grade crossing in the United States <http://safetydata.fra.dot.gov/officeofsafety/Crossing/Default.asp>.

[4] The exposure index includes the number of trains per day, the number of cars traversing the grade crossing, and the fastest train speed on the track.

[5] May 8, 2000, letter from the Secretary of Transportation to the Chairman of the National Transportation Safety Board.

[6] U.S. Department of Transportation, Federal Railroad Administration, "Using Data Produced by WBAPS Disclaimer."

Resource Allocation Procedure User's Guide[7] to prioritize crossings for upgrade. To determine the hazard index of crossings, the guide applies the FRA accident prediction formula, which is similar to the WBAPS. Under 23 *Code of Federal Regulations* 924, States are required to incorporate the relative hazard of railroad/highway grade crossings into their highway safety improvement program based on a hazard index formula.

Although the WBAPS, the FRA's Web-based accident prediction system, is primarily a tool for States to use in determining funding authority, law enforcement agencies also use it to identify and monitor unsafe grade crossings. If the crossing inventory in the WBAPS were accurate, school districts could also find the WBAPS helpful in establishing school bus routes and identifying hazardous crossings. While the inventory is not up-to-date, it represents the most comprehensive source of data available and does permit hazard identification. Ideally, school bus routes should exclude passive grade crossings; when that is not possible, the WBAPS or the State's own grade crossing index could help school districts determine the least hazardous crossing. The Safety Board concluded that the FRA's WBAPS or a State's grade crossing hazard index, as part of the school bus routing hazard identification program, could help school districts select the safest school bus routes.

Despite the Safety Board's efforts to improve school bus and grade crossing safety, needless accidents, such as this one at Conasauga, continue to occur. Following the accident, the Safety Board developed the initiatives discussed below, based on previous safety recommendations that, if implemented by each State, could reduce the number of grade crossing accidents involving school buses. These initiatives include installing warning devices at passive grade crossings, strengthening the criteria for the installation of active warning devices, installing noise-reducing switches in school buses, improving school bus driver performance and routing, and strengthening the State commercial driver's license manual and exam to include questions related to passive grade crossings.

Passive grade crossing warning devices

In its 1998 study on safety at passive grade crossings,[8] the Safety Board recommended that all passive grade crossings be equipped with highway stop signs, at a minimum. Only Idaho and Hawaii have taken the initiative to install stop signs at all passive grade crossings.

While eliminating railroad/highway grade crossings or activating them with lights and gates is ideal, the Safety Board understands that activating crossings can be expensive; installing stop signs is a less costly solution. Had the accident driver stopped the school bus at the crossing and looked for the train, she would have been able to see it and probably would not have crossed in front of it. The sight distance along the tracks for a vehicle 15 feet from the crossing was sufficient to allow a stopped driver to see a train approaching. While State laws already require that school bus drivers stop at all grade crossings, drivers can benefit from being reminded about this requirement, and a stop sign provides that reinforcement. Moreover, passengers riding the bus are unlikely to know that all school buses are supposed to stop at grade crossings. If a stop

[7] U.S. Department of Transportation, Federal Railroad Administration, *Rail Highway Crossing Resource Allocation Procedure User's Guide*, DOT/FRA/OS-87/10.

[8] National Transportation Safety Board, *Safety at Passive Grade Crossings*, Volume 1: Analysis, Safety Study NTSB/SS-98/02 (Washington, DC: NTSB, 1998).

sign is present, it is possible that passengers may question a driver if he or she does not stop or may tell their parents or teachers that the busdriver failed to stop, providing another means of oversight. The Safety Board concluded that had a stop sign been present at the Conasauga accident crossing, it would have reinforced to the driver the need to stop before crossing the tracks, likely prompting her to stop and not attempt to cross in front of the train.

Hazard index

About half the States use their own hazard index (as opposed to the FRA's hazard index) to determine priorities for upgrading passive grade crossings to active crossings. Some, such as North Carolina, plan to factor school buses into their formula. North Carolina has indicated that it will not only consider whether school buses use a crossing but will also rank passive crossings according to number of school bus trips over them and load data. Including such factors assigns higher priority to school bus crossings and results in upgrading the safety of these crossings more quickly than if the standard hazard index is used. At the time of the accident, two school buses used the Liberty Church Road crossing daily. The Safety Board concluded that had Tennessee factored school bus use into its grade crossing hazard index, the accident crossing may have had a higher priority for receiving funds to install active warning devices.

Noise reduction

Locomotive event recorder data from the train involved in the Conasauga accident indicate that the train horn was activated for about 3 seconds when the train was 952 feet from the crossing and then continuously for 9 seconds (a minimum of 574 feet) before the collision. The busdriver had the radio and overhead speaker on. Additionally, the two panels above the driver's head were covered with sound attenuation material.[9] To be identified, a sound must be 3 to 9 decibels above the threshold of detection;[10] to reach the alerting level, it must be at least 10 decibels above the ambient noise level.[11]

With the door closed and the radio on (the conditions at the time of the accident), but with the bus stopped, audibility testing revealed that the sound of the horn was only 4 decibels greater than the ambient noise when the train was just visible from the crossing; the horn was barely detectable to the volunteer busdriver. With the radio on and the door and window closed, the audio portion of the videotape did not pick up the sound of the horn over the ambient noise. Under similar conditions, but with the radio off and the door open, the sound level of the horn was 25 decibels above that of the ambient noise, and a driver would probably be able to detect the sound and be alerted to the approaching train. Therefore, the Safety Board concluded that the driver did not stop, had the radio on, and the door closed; thus she had difficulty detecting the train horn and was probably unaware of the presence of the train.

[9] While it is unclear how much this material contributed to the driver's inability to hear the train horn, it may have absorbed some of the horn sound. The Safety Board remains concerned about the effects of sound attenuation material on a driver's ability to hear an alerting signal. As explained in the Fox River Grove report, sound attenuation material reduced the volume of both the train horn and the warnings shouted by bus passengers in that accident. For more information, read: NTSB/HAR-96/02.

[10] The "threshold of detection" is the level at which a person is aware of a sound.

[11] Stanley C. Skeiber, Robert L. Mason, and R. C. Potter "Effectiveness of Audible Warning Devices on Emergency Vehicles, Sound and Vibration," February 1978, pp. 14-22.

The Safety Board made two recommendations concerning bus speakers to the NASDPTS in the 1996 Fox River Grove, Illinois, highway accident report:[12]

> H-96-50
> Develop guidelines for the appropriate placement of radio speakers and use of radios on school buses and disseminate these guidelines to your members.
>
> H-96-51
> Advise your members to check their school district buses and disable any radio speakers located immediately adjacent to the school bus drivers' heads.

The NASDPTS informed the Safety Board that it had surveyed the States and found that a majority of the States had prohibited, or had legislation pending that prohibited, radio speakers in the driver's compartment. The remaining States reviewed their policies on use of radios and radio speakers in school buses and stated that the policies were adequate to ensure that drivers can hear critical auditory information. Georgia informed its local school districts of the need to follow proper procedures, including turning off speakers, when crossing railroad tracks. The State did not require school districts to disconnect the speakers adjacent to the driver's head; Georgia left that decision to the local school districts. In October 1998, the National Safety Council revised its "Recommended Procedures for School Bus Drivers at Railroad Grade Crossings" to remind drivers of the importance of turning off radios at railroad/highway grade crossings; the revision was incorporated in the *2000 National School Transportation Specifications and Procedures*. Based on the NASDPTS survey and the association's efforts to inform its members of the hazards of not turning off the radio at grade crossings, Safety Recommendations H-96-50 and –51 were classified "Closed—Acceptable Alternate Action"[13] on February 19, 1999.

Despite the NASDPTS' efforts, the 1-year-old school bus involved in this accident was equipped with a radio speaker adjacent to the driver's head. In addition, to exacerbate the audibility problem, the driver in the Conasauga accident did not follow prescribed policy to turn down the volume at railroad/highway grade crossings. The Safety Board understands from the NASDPTS' response to Safety Recommendations H-96-50 and -51 that the speakers can also be used to transmit important information to the driver via two-way radio from the school district dispatcher. While the Safety Board agrees that information from the dispatcher is important, use of the speakers for music or entertainment broadcasts is not critical and can hamper the driver's ability to hear external auditory alerts.

Speakers adjacent to a school bus driver's head probably contribute the most to masking exterior sounds, such as train horns, but air conditioning, heaters, defrosters, wiper motors, and other sounds also help mask exterior sounds. Therefore, Florida and Kentucky have begun to install noise-canceling switches in school buses. The interrupt-type switches are spring-loaded to prevent drivers from permanently overriding normal operation of noise-producing equipment. When pressed, noise in the driver's area is reduced, improving the driver's ability to listen for

[12] NTSB/HAR-96/02.

[13] The recommendations received this classification because the actions taken met the intent of the recommendations, even though formal guidelines were not developed and school districts were reminded of the hazards of speaker use when approaching railroad tracks, but were not specifically told to disable the speakers.

audible warnings. The Safety Board concluded that if activated prior to a grade crossing, a switch that turns off all nonessential noise-making components, including, but not limited to, the radio, can help drivers hear train horns and stop as necessary.

School bus driver performance and training

Georgia and Tennessee law require that school bus drivers stop the bus before crossing railroad tracks, open the door and window, turn off the radio, look both ways, and proceed when clear. An analysis of the videotape found on the accident bus showed that the school bus was traveling about 25 mph to 30 mph down Liberty Church Road and had reduced its speed to about 15 mph prior to the crossing. The videotape recorded the driver's failure to stop. The window and door were not visible on the videotape, but no sounds associated with opening either one were audible. Had the busdriver stopped 15 feet from the crossing, as required, she would have been able to see 1,268 feet down the tracks and to observe the approaching train. Had the busdriver turned off the radio and opened the door and window, as required, she probably would have heard the train horn. The Safety Board therefore concluded that if the busdriver had followed the required procedures at the grade crossing, that is, if she had stopped at least 15 feet from the nearest rail, turned off her radio, and opened the door and window, she would have seen and heard the train and avoided the accident.

In a postaccident interview, the busdriver stated that she stopped, looked both ways, opened the door, looked in her rear view mirror to make sure the passengers were seated, then looked both ways down the track and proceeded. However, the school bus videotape contradicts this statement. Nor was the busdriver's behavior on this occasion an isolated incident; her actions were indicative of complacency at grade crossings. As recorded on the accident bus videotapes, the driver drove over the same railroad crossing, without stopping, eight other times in the previous 2 weeks. Another train engineer reported seeing a female school bus driver cross the railroad tracks in front of his train at the same location on a previous occasion, although he did not report the incident at the time that he witnessed it. The accident driver was the only female school bus driver to regularly traverse the Liberty Church Road crossing.

The Murray County School District provides annual recertification training for all busdrivers. This training, which the accident driver had received on August 12, 1999, includes information on what drivers are required to do at railroad/highway grade crossings. The driver also received training on the same subject from her previous employer and was reprimanded for talking during the lesson. The fact that the driver told police investigators that she stopped and opened the door shows that she knew the regulations for school buses crossing railroad tracks. The Safety Board concluded that although the driver had been educated on and knew the mandatory safety precautions at railroad/highway grade crossings, she disregarded the required procedures and crossed the railroad tracks without stopping on the day of the accident and at least eight other times before the accident.

The accident driver crossed the Liberty Church Road railroad tracks daily when operating over her regular route. In its 1998 study on safety at passive grade crossings,[14] the Safety Board concluded:

[14] NTSB/SS-98/02, p. 61.

> A driver's decision to look for a train may be adversely affected by the driver's familiarity with and expectations at a specific passive grade crossing and the driver's experience with passive crossings in general.

The accident busdriver may have become complacent; she had not stopped at the crossing on at least eight other occasions and, therefore, even though trains passed this crossing daily between 6:00 a.m. and 7:00 a.m., may not have perceived the danger associated with railroad/highway grade crossings. The annual training she had received apparently was insufficient to reinforce to the driver the hazards associated with grade crossings.

On January 25, 1985, the Safety Board issued a recommendation on monitoring school bus driver compliance at grade crossings to the State directors of pupil transportation for the 50 States and the District of Columbia:

> H-85-4
> Encourage local school jurisdictions to establish and enforce procedures to systematically monitor schoolbus driver compliance with railroad crossing stop requirements and routing requirements which include on scene observations of driver performance.

Georgia responded that the superintendent or staff monitored each school bus route annually and that drivers were encouraged to report any unsafe crossings. The recommendation was classified "Closed—Acceptable Action" for Georgia on November 18, 1993.[15] The NASDPTS *National School Transportation Specifications and Procedures* recommends that pupil transportation directors monitor and evaluate school bus drivers in the performance of their duties.

Based on a review of the Murray County School District files, neither the accident driver nor any other driver had been monitored or received a performance evaluation. Observing and evaluating drivers allows problems to be detected and addressed before an accident occurs. In this case, in which the driver had frequently ignored proper procedures at passive grade crossings by crossing the tracks without stopping, ample opportunity existed for the transportation director (or a representative) to have observed the driver's behavior, reviewed the videotapes,[16] or both, and taken corrective action.

Without an evaluation program in place, the school district had no proactive means of identifying drivers who were operating their buses in an unsafe manner. The Safety Board concluded that the Murray County School District did not monitor drivers nor identify and correct improper behavior, thus missing the opportunity to observe this driver's behavior at railroad/highway grade crossings. Since the accident, Murray County has implemented a program under which supervisors follow drivers who are operating school buses to evaluate their

[15] Safety Recommendation H-85-4 is classified "Closed—Acceptable Action" for 48 States and the District of Columbia and "Closed—No Longer Applicable" for 2 States.

[16] While the videotapes are intended to monitor passenger behavior, they can also be used to observe driver behavior and to educate drivers on proper actions, as necessary.

performance. The county has also been working more closely with Operation Lifesaver[17] to provide mandatory driver training about grade crossing safety.

Commercial driver knowledge of passive grade crossing safety

In addition to providing feedback to currently licensed school bus drivers, the States can incorporate knowledge of passive grade crossing safety into the driver certification process. The Safety Board recommended in its 1998 study on passive grade crossing safety[18] that the States include questions on safety at passive grade crossings in every version of the States' written commercial driver's license examinations. This would reinforce the actions that commercial drivers, including school bus drivers, should take when encountering grade crossings.

In addition to examining school bus and passive grade crossing safety, this investigation also examined the safety consequences of large longitudinal distances between lap/shoulder belt anchor points. In this accident, the upper anchorage (D-ring) and emergency retractor of the driver's continuous lap/shoulder belt were mounted to the bus body side panels approximately 16 inches behind the driver's seat. The lower anchorages were mounted to the seat and attached to the floor with tethers directly under the driver's seat. When the body separated, the driver's seat, the seat-mounted lap belt components, and part of the lap/shoulder belt remained with the chassis, while the D-ring mounted on the sidewall and part of the shoulder belt remained with the bus body. The body separation resulted in high forces exerted on the belt webbing system, which tore, and the driver was ejected from the separating vehicle components. The driver sustained minor injuries.

Because the driver's lap/shoulder belt was attached to both the bus body floor and the sidewall, with one anchor point remaining with the body and the others with the chassis, great forces were exerted on the belt. When the distance between anchor points is broad and the body separates anywhere between these points, the webbing may cause injury to the driver because of forces exerted on the webbing as the two components separate. In this accident, the webbing failed, and the driver was ejected before the belt exerted serious or fatal forces on her. While the Safety Board has not seen body separations in this location before, it is concerned that drivers can sustain serious or fatal injuries if the lap/shoulder belt anchor points are sufficiently far apart that a vehicle separation between the points results in extreme forces exerted on the driver by the webbing during an accident. The Safety Board concluded that the driver's lap/shoulder belt webbing failed due to the high forces applied to the webbing as the two parts of the school bus separated and due to the large distance between the lap belt anchor points. In the Safety Board's opinion, those responsible for pupil transportation should be aware of the potential consequences associated with lap belt anchor points that are far apart. If the anchor points are closer together,

[17] Operation Lifesaver is a nonprofit nationwide effort to educate the public and increase public awareness of the hazards at railroad-highway grade crossings and to develop proper driver behavior patterns at grade crossings. Operation Lifesaver participants include State and local officials, civic groups, safety organizations, transportation industry groups, labor groups, public information media, and private citizens.

[18] Safety Recommendation H-98-37 requests that the States "ensure that questions on safety at passive grade crossings are included in every version of the State's written drivers examination." This recommendation has been classified "Closed—Acceptable Action" for 3 States, "Closed—Acceptable Alternate Action" for 10 States, "Open—Acceptable Response" for 12 States, and "Open—Unacceptable Response" for 1 State. The Safety Board has yet to receive a response from 24 States, including Georgia and Tennessee. For more information, read: NTSB/SS-98/02.

the likelihood of a body separation occurring between them can be reduced, thereby lessening the risk of injury.

Manufacturers should be aware of the potential consequences associated with lap belt anchor points that are far apart. If the anchor points are closer together, the likelihood of a body separation occurring between them can be reduced, thereby lessening the risk of injury. The NASDPTS School Bus Manufacturers Technical Council functions as an industry advisor to school bus manufacturers and the Safety Board believes that it should notify its members of how and why the driver's lap/shoulder belt tore in this accident and of the potential consequences of large longitudinal distances between lap/shoulder belt anchor points.

Although the Safety Board has issued numerous recommendations, as previously cited, to improve school bus and grade crossing safety, needless accidents, such as this one at Conasauga, continue to occur. Following the accident, the Safety Board developed a set of initiatives, based on previous safety recommendations that, if implemented by the States, could reduce the number of grade crossing accidents involving school buses. Therefore, the National Transportation Safety Board recommends that the National Association of State Directors of Pupil Transportation Services:

> Encourage your members to use the Federal Railroad Administration's Web-based accident prediction system or the States' hazard indexes for grade crossings when developing school bus routes. (H-01-44)

> In cooperation with the States, develop and implement a program of initiatives for passive grade crossings and school buses that includes (1) installation of stop signs at passive crossings that are traversed by school buses except where an engineering study shows their installation would create a greater hazard; (2) use of information about whether school buses routinely cross passive grade crossings as a factor in selecting crossings to upgrade with active warning devices; (3) a requirement that all newly purchased and in-service school buses be equipped with noise-reducing switches; (4) enhanced school bus driver training and evaluation, including periodic reviews of on-board videotapes where available, especially with regard to driver performance at grade crossings; and (5) incorporation of questions on passive grade crossings in the commercial driver's license manual and examination. (H-01-45)

> Notify your members of how and why the driver's lap/shoulder belt tore in this accident and of the potential consequences of large longitudinal distances between lap/shoulder belt anchor points. (H-01-46)

The Safety Board also issued safety recommendations to the States, the National Highway Traffic Safety Administration, the Federal Highway Administration, the Georgia Department of Education, and the school bus manufacturers. The Safety Board also reiterated a recommendation to the U.S. Department of Transportation. In your response to the recommendations in this letter, please refer to H-01-44 through -46. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 22, 2002

In reply refer to: H-01-47

School Bus Manufacturers
(See distribution list)

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses the installation of radio speakers used for music or entertainment on school buses. The recommendation is derived from the Safety Board's investigation of the collision of a CSX Transportation, Inc., (CSXT) freight train and Murray County, Georgia, district school bus at a railroad/highway grade crossing in Conasauga, Tennessee, on March 28, 2000,[1] and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has reiterated 1 safety recommendation and issued 10 new safety recommendations, 1 of which is addressed to the school bus manufacturers. Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

On March 28, 2000, about 6:40 a.m. (sunrise was at 6:33 a.m.), a CSXT freight train traveling 51 mph struck the passenger side of a Murray County, Georgia, School District school bus at a railroad/highway grade crossing near Conasauga, Tennessee. The accident occurred as the school bus was crossing the tracks at a speed of approximately 15 mph. During the accident sequence, the driver and three children were ejected. Two ejected passengers received serious injuries and one was fatally injured. The driver, who had been wearing a lap/shoulder belt that broke during the crash sequence, received minor injuries. Of the four passengers who remained inside the bus, two were fatally injured, one sustained serious injuries, and one, who was restrained by a lap belt, received minor injuries. The two train crewmembers were not injured.

Locomotive event recorder data from the train involved in the Conasauga accident indicate that the train horn was activated for about 3 seconds when the train was 952 feet from the crossing and then continuously for 9 seconds (a minimum of 574 feet) before the collision.

[1] For more information, read: National Transportation Safety Board, *Collision of CSXT Freight Train and Murray County, Georgia, School District School Bus at Railroad/Highway Grade Crossing in Conasauga, Tennessee, on March 28, 2000,* Highway Accident Report NTSB/HAR-01/03 (Washington, DC: NTSB, 2001).

The busdriver had the radio on, and a speaker was positioned above her head. Additionally, the two panels above the driver's head were covered with sound attenuation material.[2]

With the door closed and the radio on (the conditions at the time of the accident), audibility testing revealed that the sound of the horn was only 4 decibels greater than the ambient noise when the train was 1,268 feet from the crossing; the horn was barely detectable to a volunteer busdriver. To be identified, a sound must be 3 to 9 decibels above the threshold of detection;[3] to reach the alerting level, it must be at least 10 decibels above the ambient noise level.[4] Since the sound level increases by about 6 decibels when the distance is halved, at 574 feet (the point where the horn was sounded continuously), the sound of the horn would have been about 11 decibels above the threshold of ambient noise. During the accident sequence, with the radio on and the door and window closed, the audio portion of the videotape did not pick up the sound of the horn over the ambient noise. During testing, with the radio off and the door open, even at 1,268 feet, the sound level of the horn was 25 decibels above that of the ambient noise, and a driver would probably be able to detect the sound and be alerted to the approaching train. Therefore, the Safety Board concluded that the driver did not stop, had the radio on, and the door closed; thus she had difficulty detecting the train horn and was probably unaware of the presence of the train.

The Safety Board made two recommendations concerning bus speakers to the National Association of State Directors of Pupil Transportation Services (NASDPTS) in the 1996 Fox River Grove, Illinois, highway accident report:[5]

> H-96-50
> Develop guidelines for the appropriate placement of radio speakers and use of radios on school buses and disseminate these guidelines to your members.
>
> H-96-51
> Advise your members to check their school district buses and disable any radio speakers located immediately adjacent to the school bus drivers' heads.

The NASDPTS informed the Safety Board that it had surveyed the States and found that a majority of the States had prohibited, or had legislation pending that prohibited, radio speakers in the driver's compartment. The remaining States reviewed their policies on use of radios and radio speakers in school buses and stated that the policies were adequate to ensure that drivers can hear critical auditory information. Georgia informed its local school districts of the need to

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[2] While it is unclear how much this material contributed to the driver's inability to hear the train horn, it may have absorbed some of the horn sound. The Safety Board remains concerned about the effects of sound attenuation material on a driver's ability to hear an alerting signal. As explained in the Fox River Grove, Illinois, report, sound attenuation material reduced the volume of both the train horn and the warnings shouted by bus passengers in that accident. For more information, read: National Transportation Safety Board, *Collision of Northeast Illinois Regional Commuter Railroad Corporation (METRA) Train and Transportation Joint Agreement School District 47/155 School Bus at Railroad/Highway Grade Crossing in Fox River Grove, Illinois, on October 25, 1995,* Highway/Railroad Accident Report NTSB/HAR-96/02 (Washington, DC: NTSB, 1996).

[3] The "threshold of detection" is the level at which a person is aware of a sound.

[4] Stanley C. Skeiber, Robert L. Mason, and R. C. Potter "Effectiveness of Audible Warning Devices on Emergency Vehicles, Sound and Vibration," February 1978, pp. 14-22.

[5] NTSB/HAR-96/02.

follow proper procedures, including turning off speakers, when crossing railroad tracks. The State did not require school districts to disconnect the speakers adjacent to the driver's head; Georgia left that decision to the local school districts. In October 1998, the National Safety Council revised its "Recommended Procedures for School Bus Drivers at Railroad Grade Crossings" to remind drivers of the importance of turning off radios at railroad/highway grade crossings; the revision was incorporated in the *2000 National School Transportation Specifications and Procedures*. Based on the NASDPTS survey and the association's efforts to inform its members of the hazards of not turning off the radio at grade crossings, Safety Recommendations H-96-50 and –51 were classified "Closed—Acceptable Alternate Action"[6] on February 19, 1999.

Despite the NASDPTS' efforts, the 1-year-old school bus involved in this accident was equipped with a radio speaker adjacent to the driver's head. Speakers adjacent to a school bus driver's head probably contribute the most to masking exterior sounds, such as train horns, but air conditioning, heaters, defrosters, wiper motors, and other sounds also help mask exterior sounds. In addition, to exacerbate the audibility problem, the driver in the Conasauga accident did not follow prescribed policy to turn down the volume at railroad/highway grade crossings. The Safety Board understands from the NASDPTS' response to Safety Recommendations H-96-50 and -51 that the speakers are also used to transmit important information to the driver via two-way radio from the school district dispatcher. While the Safety Board agrees that information from the dispatcher is important, use of the speakers for music or entertainment broadcasts is not critical and can hamper the driver's ability to hear external auditory alerts. Therefore, the National Transportation Safety Board recommends that school bus manufacturers:

> Discontinue the installation in school buses of radio speakers used for music or entertainment that are adjacent to the driver's head. (H-01-47)

The Safety Board also issued safety recommendations to the States, the National Highway Traffic Safety Administration, the Federal Highway Administration, the Georgia Department of Education, and the National Association of State Directors of Pupil Transportation Services. The Safety Board also reiterated a recommendation to the U.S. Department of Transportation. In your response to the recommendation in this letter, please refer to H-01-47. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Original Signed
By: Marion C. Blakey
Chairman

[6] The recommendations received this classification because the actions taken met the intent of the recommendations, even though formal guidelines were not developed and school districts were reminded of the hazards of speaker use when approaching railroad tracks, but were not specifically told to disable the speakers.

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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 23, 2002

In reply refer to: R-01-25

Honorable Jennifer L. Dorn
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In 2000, the Maryland Transit Administration (MTA)[1] experienced two similar accidents in the same location just 6 months apart. Both accidents involved the failure of an MTA light rail vehicle (LRV) train to stop at the designated stopping point at the Baltimore-Washington International Airport Light Rail Station (BWI Airport Station). In both cases, the train struck a hydraulic bumping post apparatus at the end of the track. The National Transportation Safety Board's investigation of the two accidents indicated that, although the direct cause of each accident was different, aspects of the MTA rail transit operation common to the two accidents influenced both their outcomes. Consequently, the Safety Board developed a special investigation report to address the safety factors affecting both accidents.[2]

The first accident occurred about 2:37 p.m. (eastern standard time) on February 13, 2000, when MTA train 24 (composed of a single LRV), en route from Baltimore to the BWI Airport, struck the hydraulic bumping post at the terminus of track No. 1 at the BWI Airport Station and derailed. The force of the collision detached the bumping post from the track, and the front of the train, which was lodged against the bumping post, was elevated about 3 1/2 feet into the air. Train 24 carried 26 people (25 passengers and 1 operator), 18 of whom were injured. Five of those injured had serious injuries. The MTA estimated the cost of the accident at $924,000.

The Safety Board determined that the probable cause of the February 13, 2000, accident at the Baltimore-Washington International Airport rail transit station was the train 24 operator's impairment by illicit and/or prescription drugs, which caused the operator to fail to stop the train before it struck the bumping post at the terminus.

The second accident occurred about 7:14 a.m. (eastern daylight time) on August 15, 2000, when MTA train 22 (composed of two LRVs), en route from Baltimore to the BWI Airport, struck the hydraulic bumping post at the terminus of track No. 2 at the BWI Airport Station and derailed. The bumping post separated from its attachment to the track and came to

[1] In 2000, when the accidents occurred, the MTA was called the Mass Transit Administration. On October 1, 2001, the MTA changed its name to the Maryland Transit Administration.

[2] For additional information, see forthcoming Railroad Special Investigation Report NTSB/SIR-01/02: *Maryland Transit Administration Light Rail Vehicle Accidents at the Baltimore-Washington International Airport Transit Station near Baltimore, Maryland, February 13 and August 15, 2000.*

rest in an inverted position. The leading LRV of the train came to rest on top of the overturned bumping post and about 4 1/4 feet up in the air. The roof of this LRV was partially embedded into the ceiling structure of the terminal building. Train 22 carried 22 people (21 passengers and 1 operator), 17 of whom were injured. None had life-threatening injuries. The MTA estimated the cost of the accident at $935,000.

The Safety Board determined that the probable cause of the August 15, 2000, accident at the Baltimore-Washington International Airport rail transit station was the train 22 operator's severe fatigue, resulting from undiagnosed obstructive sleep apnea, which caused the operator to fall asleep so that he could not brake the train before it struck the bumping post at the terminus.

Among the safety issues considered by the Safety Board in the course of these investigations was the adequacy of requirements governing the use of prescription and over-the-counter medications by LRV operators. During these investigations, the Safety Board learned that, although the MTA had substance abuse requirements addressing the use of alcohol and illicit drugs, it did not specifically require that safety-sensitive employees report their use of prescription and over-the-counter medications before operating equipment. Rule 1.6.2 of the MTA *Interim Rules and Instructions for Employees* prohibited employees from reporting for duty or being, while on duty, under the influence of "intoxicants, including alcohol, or Controlled Substances, *or any other substance which may impair job performance*." (Italics added.) The MTA, however, did not define "any other substance which may impair job performance" as including prescription or over-the-counter medications, many of which have side effects that can impair alertness and other job performance factors.

Both operators in the BWI 2000 accidents had been on medical leave for extended periods shortly before their respective accidents. Both had been prescribed medications that had possible side effects that included fatigue and drowsiness. Regarding the MTA's policy about employees who had been on medical leave, the MTA light rail superintendent stated in a June 12, 2000, letter to the Safety Board that the MTA does "not positively know whether a safety-sensitive employee is on medication when they return to work."

Prescription and over-the-counter medications can significantly affect the performance of people taking them. Many such medications can make the patient drowsy or dizzy, affect vision or hearing, or bring about other physical conditions that could reduce the effectiveness of a safety-sensitive employee. It appears that the MTA's policy regarding prescription and over-the-counter medications was to allow the employee to make the final determination whether he or she was fit for duty while taking a medication. But the MTA itself had no mechanism by which it could review the appropriateness of the employee's decision.

The physical condition of an employee who carries out safety-sensitive duties should be of vital interest to any rail transit system management. Management is responsible not only for the well-being of that employee but of the passengers and coworkers the employee's actions affect. Some medications, even when they are taken as prescribed or recommended, may have the effect of degrading employee performance. In some cases, legal substances such as over-the-counter and prescription drugs can impair the condition of an employee nearly as readily as illegal drugs. Consequently, the Safety Board concluded that because the MTA did not require safety-sensitive employees to report their use of prescription and over-the-counter medications, it

lacked information that could have had a bearing on the condition and performance of such employees.

The chief of the MTA benefits section told the Safety Board that the MTA followed applicable Federal Transit Administration (FTA) regulations pertaining to substance abuse and that, consistent with those regulations, the MTA had no specific requirement that employees in safety-sensitive positions inform the MTA about their use of prescription and/or over-the-counter medications. The Safety Board reviewed the FTA drug regulations at 49 *Code of Federal Regulations* (CFR) Part 653 and found no explicit reference to the use of prescription and/or over-the-counter medications by safety-sensitive employees.[3] Other rail transit organizations may also infer from the lack of FTA regulations concerning the use of prescription and/or over-the-counter medications that they do not need to require their employees to report their use of prescription and over-the-counter drugs.

In contrast to the FTA's lack of such requirements, the Federal Railroad Administration (FRA) regulations at 49 CFR 219.103 specifically address the use of prescription and over-the-counter medications by employees covered under FRA rules. The regulations permit covered employees[4] to use such medications, as determined by a physician or treating medical practitioner, if "use of the substance by the employee at the prescribed or authorized dosage level is consistent with the safe performance of the employee's duties." The FRA regulations also require that, in the event that more than one medical practitioner is treating the employee, at least one practitioner must be informed of all medications the employee is taking and must conclude that the use of the medications is consistent with safe employee performance. Moreover, the FRA regulations explicitly state "This subpart does not restrict any discretion available to the railroad to require that employees notify the railroad of therapeutic drug use or obtain prior approval for such use."

The Safety Board is concerned about the disparity between the FTA and FRA regulations concerning substances liable to cause employee impairment. Because FTA regulations do not specifically address the use of prescription and over-the-counter medications by safety-sensitive employees, rail transit operations, unlike railroad operations under the jurisdiction of the FRA, may not consider that they have the authority to monitor medication use by safety-sensitive employees. In contrast to the railroads regulated by the FRA, which may carry both freight and passengers, the rail transit systems regulated by the FTA are responsible primarily for the transport of passengers. The Safety Board concluded that, in the interests of passenger safety, rail transit systems should be at least as rigorous as FRA-regulated systems concerning possible sources of operator impairment. In the view of the Safety Board, the need for rail systems to be aware of medication use by operators is more pressing than ever when passenger safety is at risk.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Federal Transit Administration:

[3] At the time of the accidents in 2000, 49 CFR Part 653, "Prevention of Prohibited Drug Use in Transit Operations," was in effect. Effective August 2001, Part 653 was superseded by 49 CFR Part 655, "Prevention of Alcohol Misuse and Prohibited Drug Use in Transit Operations." The Safety Board's review of the new FTA regulations at 49 CFR Part 655 found that they are also silent on the use of prescription and over-the-counter medications by safety-sensitive employees.

[4] In this context, *covered employees* are those who have been assigned to perform service subject to the Hours of Service Act.

Authorize and encourage rail transit systems to require their employees in safety-sensitive positions to inform the rail transit system about their use of prescription and over-the-counter medications so that the rail transit system can have qualified medical personnel determine the medication's potential effects on employee performance. (R-01-25)

The Safety Board also issued safety recommendations to rail transit systems and the Maryland Transit Administration.

Please refer to Safety Recommendation R-01-25 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 23, 2002

In reply refer to: R-01-26 and -27

U.S. Rail Transit Systems
(See attached list)

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

The recommendations address the adequacy of requirements governing the use of prescription and over-the-counter medications by light rail vehicle (LRV) operators and the effect of sleeping disorders on the performance of LRV operators. The recommendations are derived from the Safety Board's investigation of the Maryland Transit Administration LRV accidents at the Baltimore-Washington International Airport transit station near Baltimore, Maryland, on February 13 and August 15, 2000, and are consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued four safety recommendations, two of which are addressed to rail transit systems, including your organization. Information supporting these recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

In 2000, the Maryland Transit Administration (MTA)[1] experienced two similar accidents in the same location just 6 months apart. Both accidents involved the failure of an MTA LRV train to stop at the designated stopping point at the Baltimore-Washington International Airport Light Rail Station (BWI Airport Station). In both cases, the train struck a hydraulic bumping post apparatus at the end of the track. The Safety Board's investigation of the two accidents indicated that, although the direct cause of each accident was different, aspects of the MTA rail transit operation common to the two accidents influenced both their outcomes. Consequently, the Safety Board developed a special investigation report to address the safety factors affecting both accidents.[2]

[1] In 2000, when the accidents occurred, the MTA was called the Mass Transit Administration. On October 1, 2001, the MTA changed its name to the Maryland Transit Administration.

[2] For additional information, see forthcoming Railroad Special Investigation Report NTSB/SIR-01/02: *Maryland Transit Administration Light Rail Vehicle Accidents at the Baltimore-Washington International Airport Transit Station near Baltimore, Maryland, February 13 and August 15, 2000.*

The first accident occurred about 2:37 p.m. (eastern standard time) on February 13, 2000, when MTA train 24 (composed of a single LRV), en route from Baltimore to the BWI Airport, struck the hydraulic bumping post at the terminus of track No. 1 at the BWI Airport Station and derailed. The force of the collision detached the bumping post from the track, and the front of the train, which was lodged against the bumping post, was elevated about 3 1/2 feet into the air. Train 24 carried 26 people (25 passengers and 1 operator), 18 of whom were injured. Five of those injured had serious injuries. The MTA estimated the cost of the accident at $924,000.

The Safety Board determined that the probable cause of the February 13, 2000, accident at the Baltimore-Washington International Airport rail transit station was the train 24 operator's impairment by illicit and/or prescription drugs, which caused the operator to fail to stop the train before it struck the bumping post at the terminus.

The second accident occurred about 7:14 a.m. (eastern daylight time) on August 15, 2000, when MTA train 22 (composed of two LRVs), en route from Baltimore to the BWI Airport, struck the hydraulic bumping post at the terminus of track No. 2 at the BWI Airport Station and derailed. The bumping post separated from its attachment to the track and came to rest in an inverted position. The leading LRV of the train came to rest on top of the overturned bumping post and about 4 1/4 feet up in the air. The roof of this LRV was partially embedded into the ceiling structure of the terminal building. Train 22 carried 22 people (21 passengers and 1 operator), 17 of whom were injured. None had life-threatening injuries. The MTA estimated the cost of the accident at $935,000.

The Safety Board determined that the probable cause of the August 15, 2000, accident at the Baltimore-Washington International Airport rail transit station was the train 22 operator's severe fatigue, resulting from undiagnosed obstructive sleep apnea, which caused the operator to fall asleep so that he could not brake the train before it struck the bumping post at the terminus.

Among the safety issues considered by the Safety Board in the course of these investigations was the adequacy of requirements governing the use of prescription and over-the-counter medications by LRV operators. During these investigations, the Safety Board learned that, although the MTA had substance abuse requirements addressing the use of alcohol and illicit drugs, it did not specifically require that safety-sensitive employees report their use of prescription and over-the-counter medications before operating equipment. Rule 1.6.2 of the MTA *Interim Rules and Instructions for Employees* prohibited employees from reporting for duty or being, while on duty, under the influence of "intoxicants, including alcohol, or Controlled Substances, *or any other substance which may impair job performance*." (Italics added.) The MTA, however, did not define "any other substance which may impair job performance" as including prescription or over-the-counter medications, many of which have side effects that can impair alertness and other job performance factors.

Both operators in the BWI 2000 accidents had been on medical leave for extended periods shortly before their respective accidents. Both had been prescribed medications that had possible side effects that included fatigue and drowsiness. Regarding the MTA's policy about employees who had been on medical leave, the MTA light rail superintendent stated in a June 12, 2000, letter to the Safety Board that the MTA does "not positively know whether a safety-sensitive employee is on medication when they return to work."

Prescription and over-the-counter medications can significantly affect the performance of people taking them. Many such medications can make the patient drowsy or dizzy, affect vision or hearing, or bring about other physical conditions that could reduce the effectiveness of a safety-sensitive employee. It appears that the MTA's policy regarding prescription and over-the-counter medications was to allow the employee to make the final determination whether he or she was fit for duty while taking a medication. But the MTA itself had no mechanism by which it could review the appropriateness of the employee's decision.

The physical condition of an employee who carries out safety-sensitive duties should be of vital interest to any rail transit system management. Management is responsible not only for the well-being of that employee but of the passengers and coworkers the employee's actions affect. Some medications, even when they are taken as prescribed or recommended, may have the effect of degrading employee performance. In some cases, legal substances such as over-the-counter and prescription drugs can impair the condition of an employee nearly as readily as illegal drugs. Consequently, the Safety Board concluded that because the MTA did not require safety-sensitive employees to report their use of prescription and over-the-counter medications, it lacked information that could have had a bearing on the condition and performance of such employees.

Safety-conscious rail transit agencies must consider an employee's use of substances, whether legal or illegal, that could negatively affect the employee's performance and put passengers and coworkers at risk. If use of a prescription or over-the-counter medication brings into question the performance of an employee responsible for safety-sensitive duties, the employee can be temporarily reassigned to non-safety-sensitive duties while taking the medication. But management cannot reassign its employees if it does not know that they are using prescription or over-the-counter medications that might cause impairment. Through postaccident interviews, the Safety Board found that the two operators involved in the BWI accidents each had a different perception about the MTA's policy concerning an operator's responsibility for reporting medication use. The train 24 operator was taking the pain-relievers oxycodone and Tylenol 3 when he returned to work. He did not tell anyone at the MTA that he was taking the medications, but he was under the impression that he was supposed to inform someone. The train 22 operator had been prescribed and was taking pain medications to deal with chronic back and neck pain, and at least one of the medications may have carried a safety warning about operating machinery. The train 22 operator stated that he did not believe he was obligated to show these medications to his MTA supervisors but that he had done so on two occasions.

Thus, the operator in the February 2000 accident believed he was supposed to report his medication use but failed to do so, while the operator in the August 2000 accident did not think he was obligated to report medication use, although he said he tried to report it. At the same time, the chief of the MTA benefits section told the Safety Board that the MTA did not require employees to inform the MTA about their using prescription medications, while the MTA's contract physician told the Safety Board that employees were expected to report medication use in at least some cases. On the basis of the inconsistency evident at all levels within the organization about what was required for an employee to fulfill the policy, the Safety Board concluded that MTA managers and employees were confused about the requirements for reporting medication use to the MTA.

The chief of the MTA benefits section told the Safety Board that the MTA followed applicable Federal Transit Administration (FTA) regulations pertaining to substance abuse and that, consistent with those regulations, the MTA had no specific requirement that employees in safety-sensitive positions inform the MTA about their use of prescription and/or over-the-counter medications. The Safety Board reviewed the FTA drug regulations at 49 *Code of Federal Regulations* (CFR) Part 653 and found no explicit reference to the use of prescription and/or over-the-counter medications by safety-sensitive employees.[3] Other rail transit organizations may also infer from the lack of FTA regulations concerning the use of prescription and/or over-the-counter medications that they do not need to require their employees to report their use of prescription and over-the-counter drugs. Therefore, because the MTA may be only one of a number of rail transit organizations that do not require their safety-sensitive employees to report their use of prescription and over-the-counter medications, the Safety Board believes that rail transit systems should require employees in safety-sensitive positions to inform their supervisors when they are using prescription or over-the-counter medications so that qualified medical personnel may determine the medication's potential effects on employee performance, and train the employees about their responsibilities under the policy.

The BWI investigations also raised questions about the effect of sleeping disorders on the performance of LRV operators. After the August 15, 2000, accident, the train 22 operator's physician became concerned that the operator's unexplained loss of consciousness on the day of the accident might have been caused by a sleeping disorder. On September 5, 2000, on the advice of his physician, the operator underwent an evaluation by a sleep medicine specialist. The evaluation results indicated that the operator suffered from severe obstructive sleep apnea.

During the assessment, the operator told the examining sleep specialist physician that he had "excessive daytime sleepiness sometimes." The evaluation indicated that the operator had a self-reported Epworth Sleepiness Scale value of 14, while an Epworth Sleepiness Scale value for a person without excessive sleepiness would be 10 or lower.[4] In addition, the medical testing determined that the operator demonstrated a respiratory disturbance index of 106 episodes per hour. A normal index would be less than 5 episodes of disturbance per hour, while an index indicating "severe" disturbance would be anything above 30 episodes per hour. Therefore, the operator had more than 21 times the number of breathing pauses per hour than is considered normal and more than 3 times the number of breathing pauses per hour than is considered severely disturbed. In addition, the evaluation showed that the operator's sleep latency period (the time it took for him to fall asleep under optimum conditions) was shorter than that of an individual who is not sleep-deprived.

The Safety Board sent the full results of the operator's medical sleep evaluation to the director of the Center for Sleep and Respiratory Neurobiology at the University of Pennsylvania Medical Center for assessment. This expert strongly supported the diagnosis of severe

[3] At the time of the accidents in 2000, 49 CFR Part 653, "Prevention of Prohibited Drug Use in Transit Operations," was in effect. Effective August 2001, Part 653 was superseded by 49 CFR Part 655, "Prevention of Alcohol Misuse and Prohibited Drug Use in Transit Operations." The Safety Board's review of the new FTA regulations at 49 CFR Part 655 found that they are also silent on the use of prescription and over-the-counter medications by safety-sensitive employees.

[4] The Epworth Sleepiness Scale has a range of 0 to 24. Epworth Scale values for a person without excessive sleepiness would be 10 or less, while values 11 through 24 indicate significant sleepiness.

obstructive sleep apnea and considered the operator at risk for falling asleep inappropriately. Based on its review of the sleep evaluation evidence and the verification of the evaluation findings by an independent expert, the Safety Board concluded that the train 22 operator was suffering from severe obstructive sleep apnea at the time of the August 15, 2000, accident.

Obstructive sleep apnea is a medical condition that chronically prevents those affected by it from obtaining restful sleep, creating circumstances that result in persistent fatigue no matter how much sleep is obtained during any period. Medical authorities agree that excessive daytime sleepiness is almost uniformly present in people who suffer from obstructive sleep apnea, and constant fatigue is one of the symptoms of the disorder. Because he had severe obstructive sleep apnea, the operator almost certainly had severe and persistent fatigue. He likely was so accustomed to his habitual condition of tiredness that he did not even clearly recognize that he was fatigued. On the morning of the accident, this unrelieved fatigue appears to have caused the operator to fall asleep while he was operating the train during the approach to the BWI Airport Station. Consequently, the Safety Board concluded that the chronic fatigue he was experiencing due to undiagnosed obstructive sleep apnea likely caused the train 22 operator to fall asleep as the LRV approached the BWI Airport Station on August 15, 2000.

An estimated 10 million people in the United States have undiagnosed obstructive sleep apnea.[5] This is due in large part to a lack of awareness about and appreciation of the symptoms of the disease. Its hallmarks, such as snoring and persistent fatigue, are often considered mere annoyances rather than possible symptoms of a medical condition. Consequently, people with sleep apnea frequently dismiss the indicators as insignificant. A person educated about the disease, however, might recognize them as symptoms of the condition and seek appropriate medical treatment. Similarly, if transit agencies were better educated about and focused more attention on such disorders, they might be more aware of those employees likely to have sleeping disorders and be better equipped to help employees with sleeping disorders treat the conditions safely and effectively. Consequently, the Safety Board concluded that better education about the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating the conditions could help transit agencies and their employees reduce the risk of safety-sensitive employees being impaired by chronic fatigue.

Before the BWI accidents took place in 2000, the MTA did not attempt to educate its employees or managers about how sleeping disorders could negatively affect the safety of the transit environment and about how such problems could be identified and addressed. Following the accidents, in 2001, some MTA personnel participated in fatigue awareness training, including the Transportation Safety Institute's fatigue awareness training, which includes modules addressing the major types of sleeping disorders, including sleep apnea. In addition, the MTA began developing its own fatigue awareness training program and policy.

The Safety Board is pleased with these MTA efforts in the area of fatigue awareness and encourages the MTA to develop a systematic and comprehensive program that will ensure that MTA employees are kept aware of the various safety issues involving fatigue, particularly fatigue caused by sleeping disorders. As indicated by the August 2000 accident at the BWI

[5] Information obtained in early 2001 from the Home page of the American Sleep Apnea Association <http://sleepapnea.org>.

Airport Station, such disorders can have significant system safety consequences. Given that a sleeping disorder may affect the performance of an operator employed by any rail transit system, all such systems would benefit from including a sleeping disorder component in their fatigue programs. Therefore, the Safety Board believes that rail transit systems should ensure that their fatigue educational awareness programs include the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating them.

Therefore, the National Transportation Safety Board makes the following safety recommendations to U.S. rail transit systems:

> Require employees in safety-sensitive positions to inform their supervisors when they are using prescription or over-the-counter medications so that qualified medical personnel may determine the medication's potential effects on employee performance, and train the employees about their responsibilities under the policy. (R-01-26)
>
> Ensure that your fatigue educational awareness program includes the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating them. (R-01-27)

The Safety Board also issued safety recommendations to the Federal Transit Administration and the Maryland Transit Administration. In your response to the recommendations in this letter, please refer to Safety Recommendations R-01-26 and -27. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman

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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 23, 2002

In reply refer to: R-01-26 through -28

Ms. Virginia L. White
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The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

These recommendations address the following safety issues: the adequacy of requirements governing the use of prescription and over-the-counter medications by light rail vehicle (LRV) operators, the effect of sleeping disorders on the performance of LRV operators, and the adequacy of the event recorders on the LRVs involved in these accidents. The recommendations are derived from the Safety Board's investigation of the Maryland Transit Administration (MTA) LRV accidents at the Baltimore-Washington International Airport transit station near Baltimore, Maryland, on February 13 and August 15, 2000, and are consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued four safety recommendations, one of which (Safety Recommendation R-01-28) is addressed specifically to the MTA. Two additional recommendations (Safety Recommendations R-01-26 and -27) are being sent to rail transit systems, including the MTA. Information supporting the recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

In 2000, the MTA experienced two similar accidents in the same location just 6 months apart. Both accidents involved the failure of an MTA LRV train to stop at the designated stopping point at the Baltimore-Washington International Airport Light Rail Station (BWI Airport Station). In both cases, the train struck a hydraulic bumping post apparatus at the end of the track. The Safety Board's investigation of the two accidents indicated that, although the direct cause of each accident was different, aspects of the MTA rail transit operation common to

the two accidents influenced both their outcomes. Consequently, the Safety Board developed a special investigation report to address the safety factors affecting both accidents.[1]

The first accident occurred about 2:37 p.m. (eastern standard time) on February 13, 2000, when MTA train 24 (composed of a single LRV), en route from Baltimore to the BWI Airport, struck the hydraulic bumping post at the terminus of track No. 1 at the BWI Airport Station and derailed. The force of the collision detached the bumping post from the track, and the front of the train, which was lodged against the bumping post, was elevated about 3 1/2 feet into the air. Train 24 carried 26 people (25 passengers and 1 operator), 18 of whom were injured. Five of those injured had serious injuries. The MTA estimated the cost of the accident at $924,000.

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The second accident occurred about 7:14 a.m. (eastern daylight time) on August 15, 2000, when MTA train 22 (composed of two LRVs), en route from Baltimore to the BWI Airport, struck the hydraulic bumping post at the terminus of track No. 2 at the BWI Airport Station and derailed. The bumping post separated from its attachment to the track and came to rest in an inverted position. The leading LRV of the train came to rest on top of the overturned bumping post and about 4 1/4 feet up in the air. The roof of this LRV was partially embedded into the ceiling structure of the terminal building. Train 22 carried 22 people (21 passengers and 1 operator), 17 of whom were injured. None had life-threatening injuries. The MTA estimated the cost of the accident at $935,000.

The Safety Board determined that the probable cause of the August 15, 2000, accident at the Baltimore-Washington International Airport rail transit station was the train 22 operator's severe fatigue, resulting from undiagnosed obstructive sleep apnea, which caused the operator to fall asleep so that he could not brake the train before it struck the bumping post at the terminus.

Among the safety issues considered by the Safety Board in the course of these investigations was the adequacy of requirements governing the use of prescription and over-the-counter medications by LRV operators. During these investigations, the Safety Board learned that, although the MTA had substance abuse requirements addressing the use of alcohol and illicit drugs, it did not specifically require that safety-sensitive employees report their use of prescription and over-the-counter medications before operating equipment. Rule 1.6.2 of the MTA *Interim Rules and Instructions for Employees* prohibited employees from reporting for duty or being, while on duty, under the influence of "intoxicants, including alcohol, or Controlled Substances, *or any other substance which may impair job performance*." (Italics added.) The MTA, however, did not define "any other substance which may impair job performance" as including prescription or over-the-counter medications, many of which have side effects that can impair alertness and other job performance factors.

[1] For additional information, see forthcoming Railroad Special Investigation Report NTSB/SIR-01/02: *Maryland Transit Administration Light Rail Vehicle Accidents at the Baltimore-Washington International Airport Transit Station near Baltimore, Maryland, February 13 and August 15, 2000.*

Both operators in the BWI 2000 accidents had been on medical leave for extended periods shortly before their respective accidents. Both had been prescribed medications that had possible side effects that included fatigue and drowsiness. Regarding the MTA's policy about employees who had been on medical leave, the MTA light rail superintendent stated in a June 12, 2000, letter to the Safety Board that the MTA does "not positively know whether a safety-sensitive employee is on medication when they return to work."

Prescription and over-the-counter medications can significantly affect the performance of people taking them. Many such medications can make the patient drowsy or dizzy, affect vision or hearing, or bring about other physical conditions that could reduce the effectiveness of a safety-sensitive employee. It appears that the MTA's policy regarding prescription and over-the-counter medications was to allow the employee to make the final determination whether he or she was fit for duty while taking a medication. But the MTA itself had no mechanism by which it could review the appropriateness of the employee's decision.

The physical condition of an employee who carries out safety-sensitive duties should be of vital interest to any rail transit system management. Management is responsible not only for the well-being of that employee but of the passengers and coworkers the employee's actions affect. Some medications, even when they are taken as prescribed or recommended, may have the effect of degrading employee performance. In some cases, legal substances such as over-the-counter and prescription drugs can impair the condition of an employee nearly as readily as illegal drugs. Consequently, the Safety Board concluded that because the MTA did not require safety-sensitive employees to report their use of prescription and over-the-counter medications, it lacked information that could have had a bearing on the condition and performance of such employees.

Safety-conscious rail transit agencies must consider an employee's use of substances, whether legal or illegal, that could negatively affect the employee's performance and put passengers and coworkers at risk. If use of a prescription or over-the-counter medication brings into question the performance of an employee responsible for safety-sensitive duties, the employee can be temporarily reassigned to non-safety-sensitive duties while taking the medication. But management cannot reassign its employees if it does not know that they are using prescription or over-the-counter medications that might cause impairment. Through postaccident interviews, the Safety Board found that the two operators involved in the BWI accidents each had a different perception about the MTA's policy concerning an operator's responsibility for reporting medication use. The train 24 operator was taking the pain-relievers oxycodone and Tylenol 3 when he returned to work. He did not tell anyone at the MTA that he was taking the medications, but he was under the impression that he was supposed to inform someone. The train 22 operator had been prescribed and was taking pain medications to deal with chronic back and neck pain, and at least one of the medications may have carried a safety warning about operating machinery. The train 22 operator stated that he did not believe he was obligated to show these medications to his MTA supervisors but that he had done so on two occasions.

Thus, the operator in the February 2000 accident believed he was supposed to report his medication use but failed to do so, while the operator in the August 2000 accident did not think he was obligated to report medication use, although he said he tried to report it. At the same

time, the chief of the MTA benefits section told the Safety Board that the MTA did not require employees to inform the MTA about their using prescription medications, while the MTA's contract physician told the Safety Board that employees were expected to report medication use in at least some cases. On the basis of the inconsistency evident at all levels within the organization about what was required for an employee to fulfill the policy, the Safety Board concluded that MTA managers and employees were confused about the requirements for reporting medication use to the MTA.

The chief of the MTA benefits section told the Safety Board that the MTA followed applicable Federal Transit Administration (FTA) regulations pertaining to substance abuse and that, consistent with those regulations, the MTA had no specific requirement that employees in safety-sensitive positions inform the MTA about their use of prescription and/or over-the-counter medications. The Safety Board reviewed the FTA drug regulations at 49 *Code of Federal Regulations* (CFR) Part 653 and found no explicit reference to the use of prescription and/or over-the-counter medications by safety-sensitive employees.[2] Other rail transit organizations may also infer from the lack of FTA regulations concerning the use of prescription and/or over-the-counter medications that they do not need to require their employees to report their use of prescription and over-the-counter drugs. Therefore, because the MTA may be only one of a number of rail transit organizations that do not require their safety-sensitive employees to report their use of prescription and over-the-counter medications, the Safety Board believes that rail transit systems should require employees in safety-sensitive positions to inform their supervisors when they are using prescription or over-the-counter medications so that qualified medical personnel may determine the medication's potential effects on employee performance, and train the employees about their responsibilities under the policy.

The BWI investigations also raised questions about the effect of sleeping disorders on the performance of LRV operators. After the August 15, 2000, accident, the train 22 operator's physician became concerned that the operator's unexplained loss of consciousness on the day of the accident might have been caused by a sleeping disorder. On September 5, 2000, on the advice of his physician, the operator underwent an evaluation by a sleep medicine specialist. The evaluation results indicated that the operator suffered from severe obstructive sleep apnea.

During the assessment, the operator told the examining sleep specialist physician that he had "excessive daytime sleepiness sometimes." The evaluation indicated that the operator had a self-reported Epworth Sleepiness Scale value of 14, while an Epworth Sleepiness Scale value for a person without excessive sleepiness would be 10 or lower.[3] In addition, the medical testing determined that the operator demonstrated a respiratory disturbance index of 106 episodes per hour. A normal index would be less than 5 episodes of disturbance per hour, while an index indicating "severe" disturbance would be anything above 30 episodes per hour. Therefore, the operator had more than 21 times the number of breathing pauses per hour than is considered

[2] At the time of the accidents in 2000, 49 CFR Part 653, "Prevention of Prohibited Drug Use in Transit Operations," was in effect. Effective August 2001, Part 653 was superseded by 49 CFR Part 655, "Prevention of Alcohol Misuse and Prohibited Drug Use in Transit Operations." The Safety Board's review of the new FTA regulations at 49 CFR Part 655 found that they are also silent on the use of prescription and over-the-counter medications by safety-sensitive employees.

[3] The Epworth Sleepiness Scale has a range of 0 to 24. Epworth Scale values for a person without excessive sleepiness would be 10 or less, while values 11 through 24 indicate significant sleepiness.

normal and more than 3 times the number of breathing pauses per hour than is considered severely disturbed. In addition, the evaluation showed that the operator's sleep latency period (the time it took for him to fall asleep under optimum conditions) was shorter than that of an individual who is not sleep-deprived.

The Safety Board sent the full results of the operator's medical sleep evaluation to the director of the Center for Sleep and Respiratory Neurobiology at the University of Pennsylvania Medical Center for assessment. This expert strongly supported the diagnosis of severe obstructive sleep apnea and considered the operator at risk for falling asleep inappropriately. Based on its review of the sleep evaluation evidence and the verification of the evaluation findings by an independent expert, the Safety Board concluded that the train 22 operator was suffering from severe obstructive sleep apnea at the time of the August 15, 2000, accident.

Obstructive sleep apnea is a medical condition that chronically prevents those affected by it from obtaining restful sleep, creating circumstances that result in persistent fatigue no matter how much sleep is obtained during any period. Medical authorities agree that excessive daytime sleepiness is almost uniformly present in people who suffer from obstructive sleep apnea, and constant fatigue is one of the symptoms of the disorder. Because he had severe obstructive sleep apnea, the operator almost certainly had severe and persistent fatigue. He likely was so accustomed to his habitual condition of tiredness that he did not even clearly recognize that he was fatigued. On the morning of the accident, this unrelieved fatigue appears to have caused the operator to fall asleep while he was operating the train during the approach to the BWI Airport Station. Consequently, the Safety Board concluded that the chronic fatigue he was experiencing due to undiagnosed obstructive sleep apnea likely caused the train 22 operator to fall asleep as the LRV approached the BWI Airport Station on August 15, 2000.

An estimated 10 million people in the United States have undiagnosed obstructive sleep apnea.[4] This is due in large part to a lack of awareness about and appreciation of the symptoms of the disease. Its hallmarks, such as snoring and persistent fatigue, are often considered mere annoyances rather than possible symptoms of a medical condition. Consequently, people with sleep apnea frequently dismiss the indicators as insignificant. A person educated about the disease, however, might recognize them as symptoms of the condition and seek appropriate medical treatment. Similarly, if transit agencies were better educated about and focused more attention on such disorders, they might be more aware of those employees likely to have sleeping disorders and be better equipped to help employees with sleeping disorders treat the conditions safely and effectively. Consequently, the Safety Board concluded that better education about the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating the conditions could help transit agencies and their employees reduce the risk of safety-sensitive employees being impaired by chronic fatigue.

Before the BWI accidents took place in 2000, the MTA did not attempt to educate its employees or managers about how sleeping disorders could negatively affect the safety of the transit environment and about how such problems could be identified and addressed. Following the accidents, in 2001, some MTA personnel participated in fatigue awareness training, including

[4] Information obtained in early 2001 from the Home page of the American Sleep Apnea Association <http://sleepapnea.org>.

the Transportation Safety Institute's fatigue awareness training, which includes modules addressing the major types of sleeping disorders, including sleep apnea. In addition, the MTA began developing its own fatigue awareness training program and policy.

The Safety Board is pleased with these MTA efforts in the area of fatigue awareness and encourages the MTA to develop a systematic and comprehensive program that will ensure that MTA employees are kept aware of the various safety issues involving fatigue, particularly fatigue caused by sleeping disorders. As indicated by the August 2000 accident at the BWI Airport Station, such disorders can have significant system safety consequences. Given that a sleeping disorder may affect the performance of an operator employed by any rail transit system, all such systems would benefit from including a sleeping disorder component in their fatigue programs. Therefore, the Safety Board believes that rail transit systems should ensure that their fatigue educational awareness programs include the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating them.

Finally, the BWI investigations indicated that the MTA may have problems concerning the adequacy of its event recorders. The two BWI investigations showed that each MTA light rail car contains a system for preserving a limited amount of train performance data in the event of an incident that meets a specific triggering requirement (in this case, an application of the track brakes at a train speed of at least 10 mph). The system consists of a software package that modifies the LRV's central computer system so that performance data may be stored within the car computer's memory. The data saved cover from 30 seconds before until 30 seconds after the triggering event.

When investigators first examined the available event data for the February 2000 accident, they determined that the event recorder had recorded a triggering event that occurred about the time of the accident. Further analysis, however, showed that the data recorded were inconsistent with the known facts of the accident event (that an LRV had collided with a bumping post).

A day after the initial examination of the recorder and its data, investigators found that the recorder had in the meantime documented another triggering event, which occurred after the postaccident data download. The time that the recorder showed as the occasion of this second triggering event preceded any postaccident movement of the LRV; the car was at rest throughout this period. Consequently, investigators determined that the LRV did not, in fact, experience a valid triggering event at this time. The data from the second triggering event overwrote the data from the event that had occurred on the day of the accident, even though the MTA had requested that the system be set to allow two separate triggering events to be saved before overwriting. The manufacturer was unable to explain exactly why and how these problems occurred.

In addition to the problems encountered while attempting to access the February 2000 accident data, the Safety Board identified several other specific weaknesses in the MTA's event recorder system. One significant deficiency is the dependence of the system on a trigger to begin recording. The accident scenarios presented by the two accidents at BWI, as well as many other potential accident scenarios, would not necessarily provide the triggering event necessary to activate the recording system. Also, the amount of time captured by this system (30 seconds

before the trigger and 30 seconds after the trigger, for a 1-minute total) does not provide enough information to determine how the train was being operated before the accident. Sometimes trending data are helpful to determine unsafe operating practices, and no such data are available on this system. Installing a system that continually monitors and records data can eliminate this deficiency. FRA regulations at 49 CFR 229.5(g) state that an event recorder should monitor and record data "over the most recent 48 hours of operation of the electrical system of the locomotive on which it is installed." Having the previous 48 hours of operational data available increases the likelihood that trend data will be available if needed for the investigation.

Another major deficiency of the current MTA recording system is its reliance on the functionality of the car's computer system. In an accident, the car's computer system could be compromised. Installing a recording system as an integral part of the computer system leaves the recording vulnerable not only to the trauma associated with the accident itself, but also to any electronic anomalies present in the computer. Having a separate, self-contained recording system would eliminate the possibility of the computer system compromising the recorded data.

A final weakness in the current recording system is its reliance on the car's central power source. The possibility exists for the car to lose power during an accident sequence. Under such a circumstance, the unpowered recording system could fail to receive and record significant operational and performance data during the accident's progression. Providing nominal battery back-up power to the recording system for several moments after power is lost would eliminate this deficiency and ensure that all relevant operational data are stored and kept ready for analysis.

Given the irregularities in the data recording and retention encountered following the February 2000 accident and the deficiencies of the system detailed above, the Safety Board concluded that the event recording system in place on the MTA light rail cars is inadequate to serve as a reliable accident investigation tool. The Safety Board believes that the MTA should install, on all its LRVs, independent event recorders that record and retain the most recent 48 hours of data, store data in nonvolatile memory, and have a back-up power source that would enable the entire recording system to function if electric power is lost to the car.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the Maryland Transit Administration:

> Require employees in safety-sensitive positions to inform their supervisors when they are using prescription or over-the-counter medications so that qualified medical personnel may determine the medication's potential effects on employee performance, and train the employees about their responsibilities under the policy. (R-01-26)
>
> Ensure that your fatigue educational awareness program includes the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating them. (R-01-27)
>
> Install, on all your light rail vehicles, independent event recorders that record and retain the most recent 48 hours of data, store data in nonvolatile memory, and have a back-up power source that would enable the entire recording system to function if electric power is lost to the car. (R-01-28)

Safety Recommendations R-01-26 and -27 were also issued to other rail transit agencies. The Safety Board also issued a safety recommendation to the Federal Transit Administration. In your response to the recommendations in this letter, please refer to Safety Recommendations R-01-26 through -28. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

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Chairman